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ABSTRACT

Serving as a guide to the outdoor areas of Powell County, Montana, and the surrounding area, this resource book is useful for teachers who wish to explore the out-of-doors with their students, particularly those interested in nature studies. Its aim is to produce a citizenry that is knowledgeable concerning the biophysical environment and its related problems. Three major sections constitute the guide. Section 1, Biome Descriptions, gives a general and detailed description of plant communities in Powell County followed by their associated soil profiles. Section 2 offers a summary of field sites. Underdeveloped sites throughout the county are suggested which allow for study of water environments, biomes, soil areas, fire burns, clear cuts, pollution areas, animals, range management, and geology. Established outdoor environmental areas in six communities are then covered in detail. This includes a general description of the area, choice of location, pictures and maps, and a site analysis chart of biotic and abiotic features. Sixty field activities which can be completed at the outdoor sites are enumerated in Section 3. Each activity gives topic of study, grade level, site(s) in which it may be undertaken, procedures, and related information. This work was prepared under an ESEA Title III contract. (BL)

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QUALITY ENVIRONMENTAL IN-SERVICE CURRICULUM CENTER

County High School Telephone: 406 836-2757

Gary D. Swant, Director

DEER LODGE, MONTANA 59722



U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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TITLE III OF THE ELEMENTARY AND SECONDARY EDUCATION ACT

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WHY THE EMPHASIS ON ENVIRONMENTAL EDUCATION IN POWELL COUNTY

For years in the teaching of elementary and secondary education, there has been an effort to tie the many disciplines together into a unified whole for the student.

Within this same time period there has been a re-realization by some that we are an integral part of nature. At one time when man was a nomadic people who lived off what nature would yield man knew the lesson of a balanced and unbalanced system. This lesson seems to have been forgotten as man's technology increased. What man has also forgotten is that if nature is put out of balance it will balance itself again only the second time the adjusted balance may be less desirable for man. With this re-realization of balance man has found that nature has given man little time to aid in this balance to produce life acceptable to man.

If we are to obtain this quality balance in the biosphere all areas of life and all peoples must be informed and become "environmentally conscious". Commissioner Allen, of the office of education, in "A Role for American Education", May, 1970, states the role of American education in the next decade must be, "All Americans must be given the opportunity through programs of environmental education to develop ecological values that are equal to or greater than the political, social, economic, and religious values that have been the basis for human decision-making process. Changes in attitude and behavior must come as expressions of individual choice, and hopefully our education programs will provide sufficient information to create awareness of environmentally desirable options."

Clearly, the guidelines have been laid for us, but we can not develop this "environmentally conscious" citizen with a one day conservation program in the fourth grade or a two week ecology course as part of the sophomore biology course. We will only develop this citizen through an interdisciplinary effort planned so that the student understands the role of his life, as it relates to his immediate surroundings and the biosphere.

With this type of feeling we went to the high school board, and to the District One board, at their teacher's request and had placed in their minutes the following policy.

"The board of trustees of Powell County High School endorses the philosophy that the creation of an informed citizenry in the area of the bio-physical environment and its associated problems is an important part of the over all education process and appropriate learning opportunities should be available to students of Powell County High School."

With this beginning we filed for federal funds to begin developing the Powell County Environmental, Inservice Curriculum Center. Our primary goal is to give teacher training, equipment, written materials, and outdoor areas to work in with their students in the area of environmental education. Of course, by helping the teachers we hope to bring about certain changes in the students which are as follows.

1. An understanding that man is a part of nature and governed by its laws, rather than separate from it.
2. An understanding for the basic cycles that maintain life on earth.
3. An understanding for the term 'balance of nature'. That is the student should understand what organisms depend on for life.
4. An understanding for the degradation that can take place in nature without careful planning by man.
5. An understanding for the desirable solutions for man's environmental problems.
6. Ways in which nature can be measured and studied.
7. A knowledge of the environment which is within the student's realm of experience. This includes the state flower, common flowers, trees, etc.

We have also set objectives for the center itself.

1. To provide a series of in-service training with university consultants on environmental issues for the rural and elementary schools involved.
2. The curriculum and in-service center will purchase and/or produce with the aid of the teachers participating in the in-service training, environmental kits, equipment, and library materials.
3. We will set and develop an out-door laboratory in each of the towns found within the county.
4. We will aid the schools in all ways possible in the teaching of environmental education.

In addition to the above goals and objectives we have set up the following grade level objectives.

Primary Grades-- Objectives based on outdoor laboratories and class room activities.

Basic skills and processes of science of science (use of senses, measurements)

Characteristics of soil, air, water, organisms
 Life cycles (change, time relations)
 Populations (numbers, time)
 Change
 Homes, habitats, and needs of
 Weather, Seasons
 Behavior
 Effects of man
 Avenues of damage
 Pollution
 Health
 Valuing living things
 Appreciation of natural beauty (aesthetics)

INTERMEDIATE GRADES--Reinforcement of the above(4-6)

Integrated processes of science (experimentation, models)
 Collecting and sampling techniques
 Finding and using sources of information
 Energy(light, heat, temperture)
 Local changes
 Complementary factors and living things
 Communities
 Attitude of inquiry
 Sense of need to improve environmental relations

MIDDLE SCHOOL, JUNIOR HIGH SCHOOL- (7-8)

More complex instances using integrated process of science
 Greater independence of finding and using sources of information
 Environmental changes, succession
 Interactions
 Ecosystems
 Decision-making (action on issues)
 Sensitivity to matters of environmental concern

HIGH SCHOOL

Evaluation using criteria
 Judging validity of information
 Recognition of interrelatedness of factors in environmental problems
 Environmental planning
 Desire to acheive constructive solutions to environmental problems

The above listing is a spiral approach to the teaching of environmental education. Within each group there is room for the student to branch into any special area, but there will still be a logical sequence to his education.

The result of such a program should be an environmental-conscious student, and future citizen. This is especially true with the one man one vote concept and the 19 year old vote.

Sources of Resource Personnel for Assisting with Environmental
 Education

This list agencies of local, state and federal government which commonly have personnel available to assist with environmental education programs. This list is not complete. You are encouraged to seek out and use the services of anyone who can help with your teaching activity.

LOCAL

City Health Department
 City Water Department
 County Commissioners
 County Superintendent of Schools
 County Weed Districts
 Soil and Water Conservation Districts

STATE

Montana Department of Lands and Investments
 Montana Department of Public Instruction
 Montana Experiment Station
 Montana Fish and Game Department
 Montana Forestry Department
 Montana Highway Commission
 Montana Water Resource Board
 University of Montana (all units)

FEDERAL

Agricultural Stabilization and Conservation Service
 Bureau of Indian Affairs
 Bureau of Land Management
 Bureau of Sports Fisheries and Wildlife
 Cooperative Extension Service
 Forest Service
 Rural Electrification Administration
 Soil Conservation District

INTRODUCTION

This booklet has been put together at the Powell County Environmental In-service Center for your use as a guide to the outdoor areas of Powell County and the surrounding areas.

The form of this book, being looseleaf, is designed so that as other areas are developed in the county additional sheets can be sent to you and placed in the book.

The main topics of this book are; ecological areas, including both plants and animals descriptions, geology, aquatic, and a description of the biomes and their locations within the county.

Powell county is a large county and a general description of it would be rather hard to give, but in general it is a part of the tiaga biome, or coniferous forest biome. This means that annual precipitation is low with four distinct seasons and the principle plant life being coniferous forest.

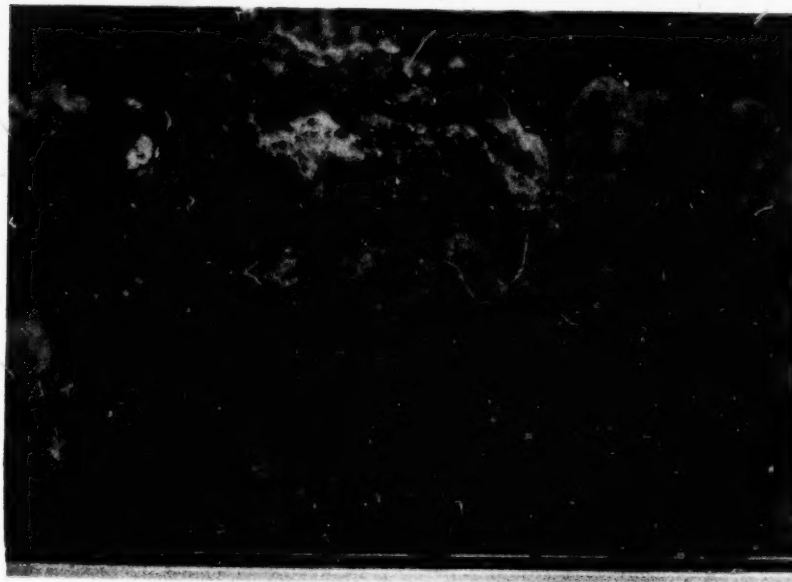
Because of our distance from the Pacific Ocean and our extremes in elevation in Powell county we find a large number of community types here. Even though we are a coniferous forest biome we can find within this biome semi-arid deserts, grasslands, coniferous forest (Douglas fir, lodgepole, spruce-fir and white bark pine), and a pine tundra all within a few miles of each other.

PICTORIAL REVIEW OF THE COMMUNITY TYPES FOR THE COUNTY OF POWELL

(This is a general listing. Sub-communities may be found.)

The photographs shown here of the community types are arranged from primitive to well-developed, and from lowest to highest elevation.

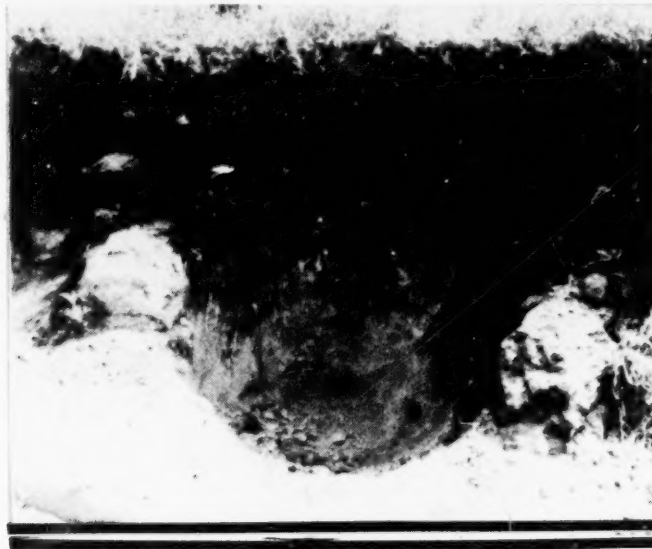
Refer to the diagram on page 13 for the listing of the major plant types found in each community and its associated soil type and name.



(1)

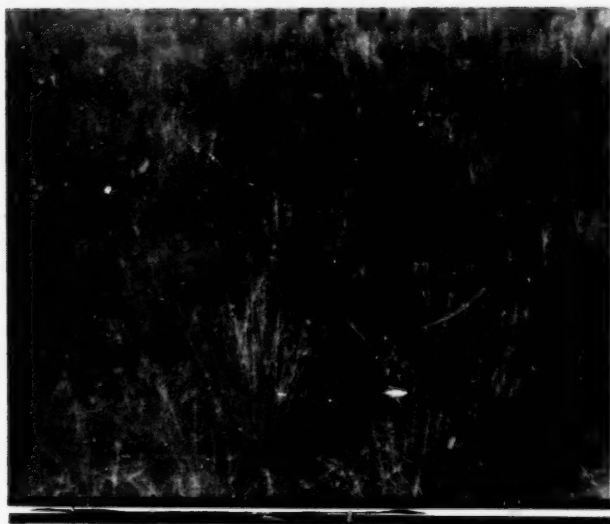
The most primitive community is that of the lichen on the rock as shown in photograph (1). Notice the amount and variety of lichen on this granite rock.

Eventually the lichen break down the rocks to soil by acid secretions which create pits in the rocks where water can then enter and freeze, speeding the break-down process. This is shown in photograph (2). Soil is also a biological community made up of both macro and micro plants and animals.



(2)

Once we have the soil we then develop the more accepted plant communities. The type of community depends on the temperature and available moisture which are both related to the elevation. The picture above is the soil type that we would find under a grassland. Notice the typical dark A horizon followed by a light B and a Cca horizon. There has been much discussion as to what is more important in the formation of soils--the geological deposition or the plant types above them. It is easy to see in Powell County that it is the plant types for if you look at a north-south slope of the same geological origin soils will be different. On most of these slopes, the north will have a douglas fir forest and the south will have a grassland, each with its associated soil types.



(3)

The lowest elevation community in Powell County is found at 6,000 feet. At this elevation the precipitation is rather low and there is a shortgrass community made up of blue-bunch wheatgrass and idaho fescue. Notice the amount of bare ground between the bunch grasses in photograph (3). This is a definite sign of low annual precipitation.



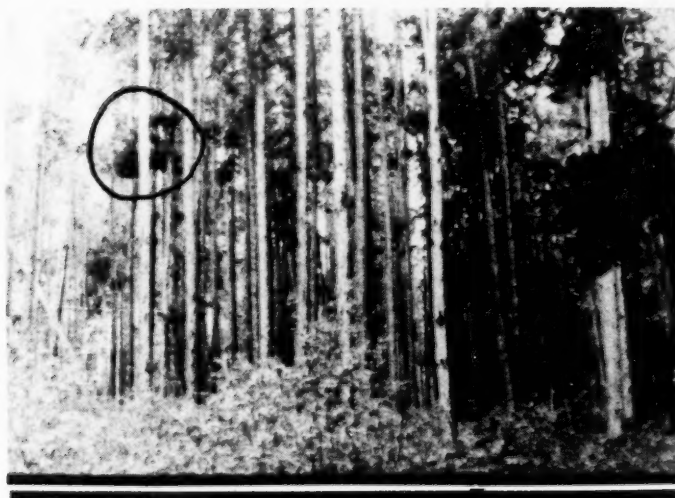
(4)

As the elevation rises to 6,500-7,000 feet (depending on the terrain) a new type of grass community appears called the tall grass community and the dominant species of grass are idaho fescue and rough fescue. Notice the height of these plants compared to the short grass community. The ground cover is near 95% and there are many associated forbs, especially lupine, yarrow, and potentilla.

At a still higher elevation is the Douglas fir zone. In much of Powell County the Douglas fir (see photograph (5)) has been replaced by lodgepole (see photograph (6)) for lodgepole is shade intolerant and comes in after a fire.



(5)



(6)

Eventually, as the lodgepole forest grows to maturity it shades the forest floor and its own seedlings can not grow in the shade. The Douglas fir then returns. In picture (7) the Douglas fir (indicated by the arrow) is coming up under the lodgepole. The term used to describe this process is succession.



(7)

Another factor that affects the forest of Powell County is mistletoe. This is a parasitic plant that grows on a tree and lives off the tissues of that tree. Note the square in the picture (8) for what it looks like. As the plant matures it ruptures and sends its spores as much as 60 feet away from itself to infect another tree. The effect on the tree is to cause a deformity in the limbs as indicated by the circle on the lodgepole in picture (6) on the preceding page.



(8)



(9) Above the lodgepole and fir zone is the spruce zone. There is very little spruce in this zone---the majority of the trees are subalpine fir with a small number of spruce trees.



(10) Above the spruce fir is found some white bark pine (albiculus pine--see picture 10) and alpine larch (see picture 11 on the following page). Both are found near the timberline. Alpine larch is the only conifer in this area that is deciduous.



(11)



(12)

Above the larch and albiculus communities there are many deformities in the trees due to the extremes in weather to which they are subjected. Pictures (12) and (13) were taken in the Racetrack range at timberline. Picture 12 is a flag tree in a meadow (species-alpine fir). It is not difficult to see from which direction the icy winds come. Note that even the bark has been peeled away (see arrow).



(13)

In other areas at this altitude (9,200--10,000 feet) the weather is so severe that the trees do not develop an upward trunk but rather spread laterally across the ground for as far as 20 feet. This is because the climate is less severe closer to the ground. The tree in picture (13) is a sub-alpine fir about 400 years old. The growth rate for these trees is 120 years per inch of diameter compared to 15 years per inch of growth in diameter 1000 feet lower. The name for this kind of growth in a tree is *krumholtz*.



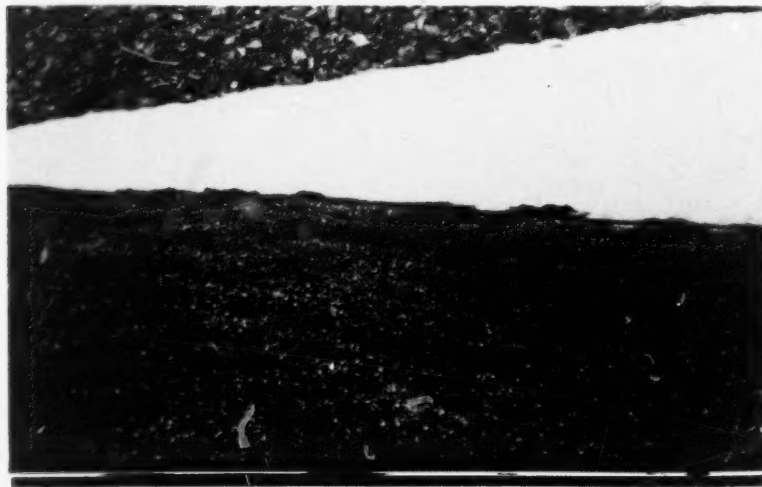
(14)



(15)

Above the zone of krumholtz is the alpine tundra zone. The basic reason for the lack of trees is the lack of carbon dioxide needed to support extensiv photosynthesis and tissue development. Picture (14) was taken the second week of July, 1971. Spring had not yet come to this area. Picture (15) shows the characteristic rolling meadows of dark soils covered nearly 100% of the time by small forbs and some bitterbrush. The large bare rocks are also characteristic of the alpine tundra zone.

Summer is of short duration in the alpine tundra zone, and flowers must bloom and produce seeds quickly before the snows come again. The flowers in picture 16 are blooming right next to the snow bank, and often the marshmarigold (*Caltha leptosepala*) is found blooming in or under the snow.



(16)

LOGGING PRACTICES

A growing industry in the valley which is affecting the biomes of the valley is logging. In recent years the most controversial practice has been that of clear cutting. Clear cutting has been used for economic reasons and as an effective control against mistletoe (see page 9). Opposition has been centered around the lack of aesthetics and the erosion on steep, shallow sil sites. In areas where this has occurred these are just criticisms.



IMMEDIATELY AFTER CUT



SLASH HAS BEEN PILED AND BURNED

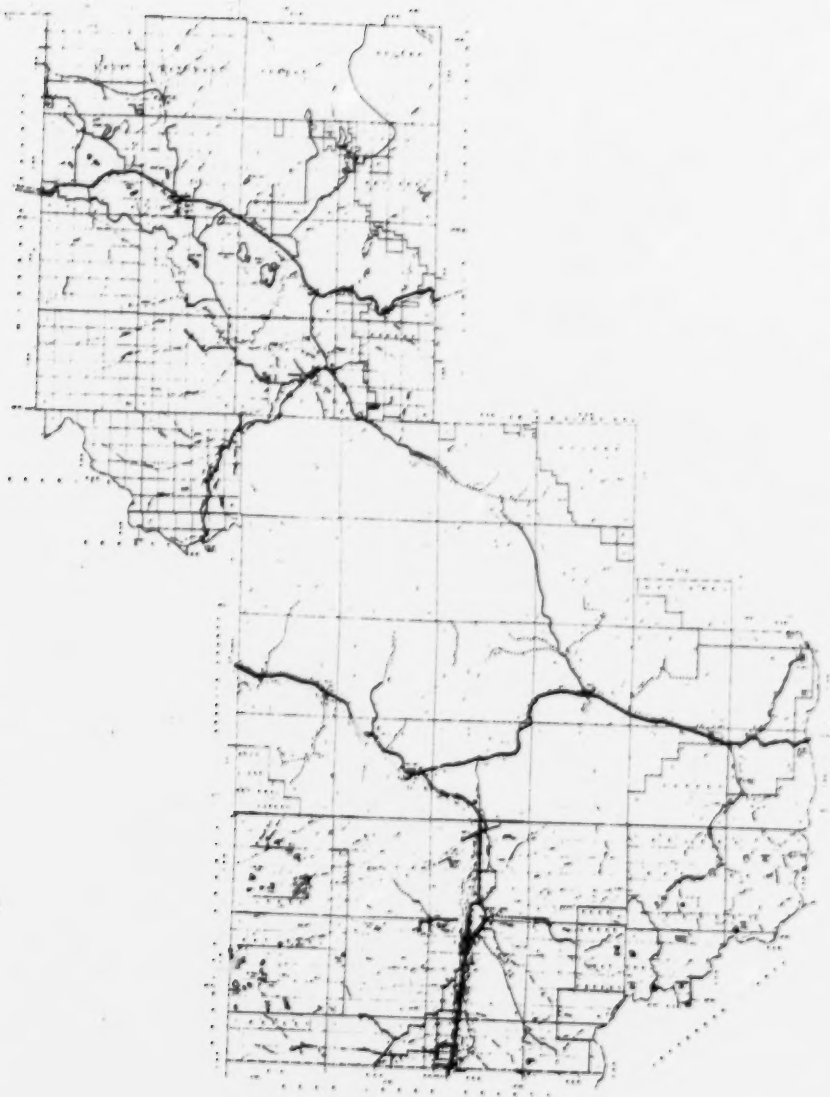
However, clearcuts do have their place. They can be part of the multi-use of the land. They increase grass for a few years followed by brush for game, followed by a good disease-free stand of trees. All four of these pictures were taken in the Dry Cottonwood area of Powell County. Note that in the third picture regrowth has been so great that thinning needs to be done, and the results of the thinning are shown in picture 4.



12 YEARS LATER, NO THINNING



LOGEPOLE THINNED TO PROPER SPACING



DETAILED DESCRIPTION OF COMMUNITIES

In describing the general community types of Powell County let us assume that we are in a typical valley of 4,600 feet elevation and the surrounding mountains range from 8,500 to 10,000 feet in elevation. Within the valley we will find ourselves in a grassland community that is climax and consisting of bunch grasses (bluebunch-wheatgrass *Agrobrion spicatum* and Idaho fescue *Festuca idahoensis*).

The reason that the bunch grass is climatic here is that we obtain 70% of our moisture in the months of June and July and the rest of the summer is dry.¹ The bunch grass seems to be able to resist and compete better on these types of sites than do other grasses. Bluebunch wheat grass is able to live and reproduce with even less precipitation than Idaho fescue and is found on the lower elevation sites. In certain areas of the county you might also find climax Rough Fescue *Fescue scabrella* in pure stands.

Overgrazing in much of the county has decreased the abundance of the climax dominant species and many other plants and forbs have taken their place on the range. One can still find the climax areas along roadbeds, graveyards, and isolated fields.

Because the climax species decrease rapidly under grazing they have been given the name decreasers and the plants which move in after them are called increasers. If the range is seriously overgrazed other plants called invaders also come in and replace the climax and increasers plants. A fourth group of plants that one will find here in the valley is the poisonous plants.

Following is a list of the decreasers, increasers, invaders, and poisonous plants found in Powell County. The list may be incomplete for some groups, but it does include all the common plants that one may encounter.

Nearly all of the plants listed here may be found on file in the Center's herbarium. Within the herbarium there are many other plants as well--some 150 genus listed with many species in each.

Many of these grassland communities have numerous streams which develop a whole new community around them. It is said that the presence of a stream in a biome will introduce the next higher biome in elevation to this area. Usually in the grassland communities these micro-communities are dominated by willows (*Salix* spp.), and the cottonwoods (*Populus angustifolia*, *P. trichocarpa*, and *P. tremuloides*). The dense understory of this cottonwood-willow community consists of a variety of rushes, sedges, grasses, and herbs. If the grassland is at a high enough elevation the dominant species of tree will be the Douglas fir (*Pseudotsuga taxifolia*) or conifer.

1. Note the climatogram summary for the exact meteorological information (page).

DECREASERS

Antelope Bitterbrush*
Big bluegrass
Bluebunch wheatgrass
Canby bluegrass
Canada bluegrass
Giant wildrye
Green needlegrass
Geranium (sticky)*
Idahoe fescue
Indian ricegrass
June grass
Little bluestem
Mountain brome
Needle-and-thread
Nuttall's saltbrush*
Prairie sandreed grass
Rough fescue
Sand dropseed
Shadscale*
Sideoats grama
Slender wheatgrass
Thickspike wheatgrass
Timber outgrass
Winterfat

INCREASERS

Arrowleaf balsamroot*
Arrowgrass
Baltic rush
Big sagebrush*
Blue grama
Buffalo grass
Common chokecherry*
Cudwee sagewort*
Death camas*
Fringed sagewort*
Greasewood*
Loco*
Larkspur*
Lupine*
Meadow barley
Needle-and thread
Phlox*
Plains muhly
Sandsberg blue
Sheep fescue
Service berry*

INVADERS

Broom snakeweed*
Canada bluegrass
Cheatgrass brome
Foxtail barley
Kentucky bluegrass
Little barley
Red three awn
Western wheat
Tumblegrass
Rubber rabbit brush*
Dandelion
Silver sage*
Snowberry*
Thrend sedge
Two groved loco
Wild onion*
Yarrow*

POISONOUS

Arrowgrass
Chokecherry*
Death camas
Greasewood*
Loco*
Larkspur*
Lupine*
Two groved loco

* Forb or shrub.

ENVIRONMENTAL SCIENCE ADMINISTRATION
U. S. DEPARTMENT OF AGRICULTURE WEATHER BUREAU
IN COOPERATION WITH COOPERATIVE NATIONAL SERVICE
CLIMATOGRAPHY OF THE UNITED STATES NO. 20-24

CLIMATOLOGICAL SUMMARY

STATION: DEER LODGE, MONTANA

MEANS AND EXTREMES FOR PERIOD 1935-1964 (30 years)

Temperature (°F)														Precipitation Totals (Inches)										Mean number of days					
Means						Extremes								Mean degree days						Snow, Sleet				Precip. 10 inch or more		Temperatures			
																				</									

(a) Average length of record, years.

* Also on earlier dates, months, or years.

† Trace, an amount too small to measure.

* Less than one half.

** Base 65°F

CLIMATE OF DEER LODGE, MONTANA

Deer Lodge is in the Park Fork of the Columbia River Valley, within the Great Northern Continental Divide at the closest point, the nearest area lies within 20 to 40 miles of Clark Fork mountains. This particular valley averages quite high elevations above sea level, up to 5,000 to 6,000 ft. a few miles upstream in the Anaconda region. The valley is surrounded by mountains to the Continental Divide to east and south, Garnet Range to the north, and the Flinn Creek Range to the west. At Deer Lodge the Clark Fork drains northeast for a few miles, then turns generally west-northwestward, reaching the Idaho border several hundred river miles downstream. This general configuration of mountains and valleys is quite important in shaping Deer Lodge climate features.

Perhaps one of the most agreeable climate features is the usual combination of comfortably warm days and pleasantly cool nights during summer and early fall seasons. Really "hot" summer weather, as reference to the above table will confirm, is rare. Oppressive combinations of heat and high relative humidity are unknown. On only 9 days in an average year will an afternoon high reach 90° or warmer, and 100° has been reached only twice in the 30 years 1935-64. Winters, while cool, are not as cold as might be expected at this altitude and location. While minimum temperatures 32° or colder are observed on 203 days in an average year, lows of zero or colder occur on only 21 days, and lows as cold as -25° are uncommon.

Sheltered at least partially in all directions by mountains, Deer Lodge escapes the worst effects of most stormy weather. The result is a rather large proportion of clear and sunny days most of the year. For example, annual snowfall averages only 28.2 inches-one of the lower annual average snowfall figures in Western Montana. Rainfall averages a little less than 11 inches a year, with only 34 days showing a tenth of an inch or more. The surrounding mountains, however, have much heavier winter snowfall than the valley, sufficient in fact to produce a good supply of irrigation water most of the summer in most years. Also significant in the precipitation picture is the fact that 7.56 inches, or 71 per cent of the annual average, fall during the growing (April-September) season. Normal years, therefore, have enough rainfall for many types of dryland farming and ranching.

Even though a 10.64-inch total is classed as semi-arid, 7.56 inches during the warm half of the year compares favorably with most of Montana.

In the Deer Lodge Valley, frosts and freezes don't have quite the same effects as in the warmer parts of Montana, largely because agriculture concentrates on hardy crop types not susceptible to frost damage early and late in the season-at least down to about 25°. Freeze details for 5 temperatures are listed in the "FROST TABLE" on the reverse of this page, but the average freeze-free season for 32° is only 95 days, indicating that tender varieties would not mature in most - perhaps 9 out of 10 - years. The longer average seasons, between 28° and 24° occurrences, indicate favorable conditions for many hardy varieties; there are 151 days in an average year between 24° freezes.

Review of the above table will describe many other features of Deer Lodge climate, but the general character can be summarized briefly: there is much bright, sunny weather, mainly late spring to early fall, but sunny skies are not uncommon during the winter - even on the coldest days. Summer mornings are mostly clear, but on about 25 days a year (mostly mid-May to mid-August) an afternoon thunderstorm will occur. Once in a while hail may fall with a thunderstorm, but only rarely is it large enough to be troublesome. Winter cold waves, with snow and sub-zero temperatures, occur at least once each winter, but the valley is protected from most Arctic air invasions by the Continental Divide to the east. The Arctic air has to build to a depth of about 7,000 ft. above sea-level before it can spill westward into this portion of the Clark Fork Valley. Late fall and early winter mornings sometimes will have fog, but most of the time the fog will "lift" or "burn off" by noon or shortly after. Really severe storms (excessively heavy rains, extreme winds, tornadoes, etc.) are practically unknown in this area, demonstrating the protection afforded a high mountain valley by a surrounding shield of higher mountains.

"Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U. S. Department of Agriculture. For U. S. Aashelm, Director of Extension Service, Montana State Univ., Bozeman, Montana."

The transition from grassland to forest in the Deer Lodge valley is usually through the transition of the Idaho fescue with the Douglas fir. In some areas of the county the transition is between Ponderosa pine (*Pinus ponderosa*) or Juniper (*Juniperus communis*). The Ponderosa pine is lacking in the area around Deer Lodge, but can be found in the northern part of the county. The exact reason for its lack in the Deer Lodge area is not known, but it may be connected to the length of the growing season.

The reason for lower timber line is not exactly known, but it is most likely related to the lower tolerance level of available moisture for tree seedlings. In any case, in most areas of the county the line or ecotone is quite abrupt.

One must remember that the plant communities are related to water and the higher in elevation one goes the more annual precipitation there is.

The typical community of the Douglas fir zone supports an undergrowth principle composed of pine grass (*Calamagrostis rubescens*) and the heart-leaved Arnica (*Arnica cordifolia*). Scattered shrubs such as common Juniper, Oregon grape (*Berberis repens*) and kinikinnick (*Arctostaphylos uva ursi*). Within the Douglas fir forest many other forbs grow as well depending on light and available moisture. Examples are lady slipper (*Calypte bulbosa*), clematis (*Clematis columbiana*), buttercups (*Ranunculus spp.*) and others.

Much of the areas of Powell County where the Douglas fir has grown at different times has had a history of fire and logging and much of the original stand has been eliminated. Where this has happened the Lodgepole pine, a shade intolerant species has replaced the Douglas fir and is in a subclimax or seral stage. Here in our county as well as many other areas, the US Forest Service has logged these areas by various methods and has held these stands in a subclimax stage. The understory of the Lodgepole pine (*Pinus contorta*) is much the same as that of the Douglas fir, except on many of the immediate slopes are found an understory of low red huckleberry bushes (*Vaccinium scoparium*).

Because of the extensiveness of the Lodgepole pine here in Powell County it is worth mentioning how it comes in after a fire on a Douglas fir stand and also how it regenerates itself once there is a stand of it.

Lodgepole pine is the opposite of the Douglas fir--that is, it is shade intolerant and grows only in the full sunlight. The Douglas fir on the other hand is shade tolerant and grows only in the shade. When we talk of shade tolerant and intolerant trees we are speaking of the environmental qualities that must be present for seed germination. After a Douglas fir the Lodgepole is better able to compete for the site and in a few years develops into an even-age stand.

If there is a fire in Lodgepole, the Lodgepole is again favored. Two distinct types of cones are produced on the Lodgepole--a fire-resistant cone and a normal cone. The fire-resistant cones, called serotinous, remain viable for long periods of time and open at a temperature of 133°F. Thus, the species is adapted to reseeding after a fire has opened the cones. It is also possible that the exposed soil surface temperatures after logging would occasionally be high enough to open the closed seed cones.

As the elevation gets higher and the environment is cooler with more water, the climax species of the Douglas fir zone gives way to climax forest of the Engleman spruce (*Picea englemanni*) and subalpine (*Abies lasiocarpa*). Again, as with lower timberline, the limits of this species is the availability of the moisture for seedling survival. This ecotone is not nearly as well defined as the grass-doug fir ecotone, but rather is a gradual transition. This is the highest of the communities until we reach timberline.

The spruce-fir zone is easily identified by the dense growth, and the slenderness of both the Engleman spruce and the subalpine fir.

The undergrowth is sparse and dominated by false huckleberry (*Vaccinium scoparium*) and bear grass (*Xerophyllum tenax*). In most of Powell County the spruce is not found in too large of stands, but is restricted to cooler areas of swamps, creek beds and north slopes. On the other hand, there are extensive stands of the subalpine fir found around the 8,000 foot level. The understudy at the upper elevations of the spruce-fir forest is characterized in addition to the two mentioned above by globeflower (*Trollius laxus*), shooting star (*Dodecatheon* spp.), and others. In the wet bogs of these elevations are found elephant-head (*Pedicularis groenlandica*), American bistort (*Polygonum bistortoides*), and bluebells (*Mertensia ciliata*).

Near the timberline the understory composition again changes and includes many typical alpine plants, sedum, mountain heath, yellow heath, dwarf huckleberry, snowflower, forget-me-nots, and others. Also at these elevations are isolated groves of Alpine larch (*Larix lyalli*) on the northern slopes.

Upper timberline here in Powell County is as little understood as it is anywhere else, and many theories have been proposed to explain it. The most important of these is the amount of CO₂ present in the air. Some feel that there is just enough to continue life and not enough for extra growth. There is of course, that point at which no growth is supported. This does not explain the local variation of heights in the timberline that one sees. It is probably related to movement of snow, soil, and light as well as the CO₂ level.

Above the timberline is the alpine environment which might best be described as one of extreme conditions which provide only near minimum requirements essential to the maintenance of life.

Alpine communities are scattered or microcommunities are scattered throughout the rocks and are not extensive in any areas in Montana except for here in Powell County in the Racetrack or Flint Creek range and in Southern Montana in the Beartooth area.

The Alpine communities exist only because of the adaptations of the plants which are found there. Most plants are low, fuzzy, and have a short life cycle. Most also take advantage of the tremendous amounts of radiant energy which is found with less atmospheric interference. Leaves of wild roses, for example, are sometimes found with temperatures 40° warmer than the air temperature.

All of these communities will not be found together in any one area, but in general they are the communities that are found in Powell County. Local variations will be present due to topography and direction of slopes.

Several roads through the county will show one most of these communities. The road over Dalton Mountain from Finn to Lincoln begins in an Artemisia stand and rises to the Spruce-fir zone. The same sequence of biomes or communities can be seen by taking the road from Deer Lodge to Boulder over Blizzard mountain, only here one starts in rabbit rubber brush instead of Artemisia. The entire community sequence can be seen in travelling from Racetrack campground to Alpine Lake and Racetrack Peak. This road is a four-wheel drive road to the lake and then trail on to Racetrack Peak.

SOILS *****

Within each community type of plants there is a distinct type of soil. The soil of an area is directly related to the type of vegetation found in the area and is as distinct as the plants.

The following chart shows the major plant communities found in Powell County and their associated soil profiles.

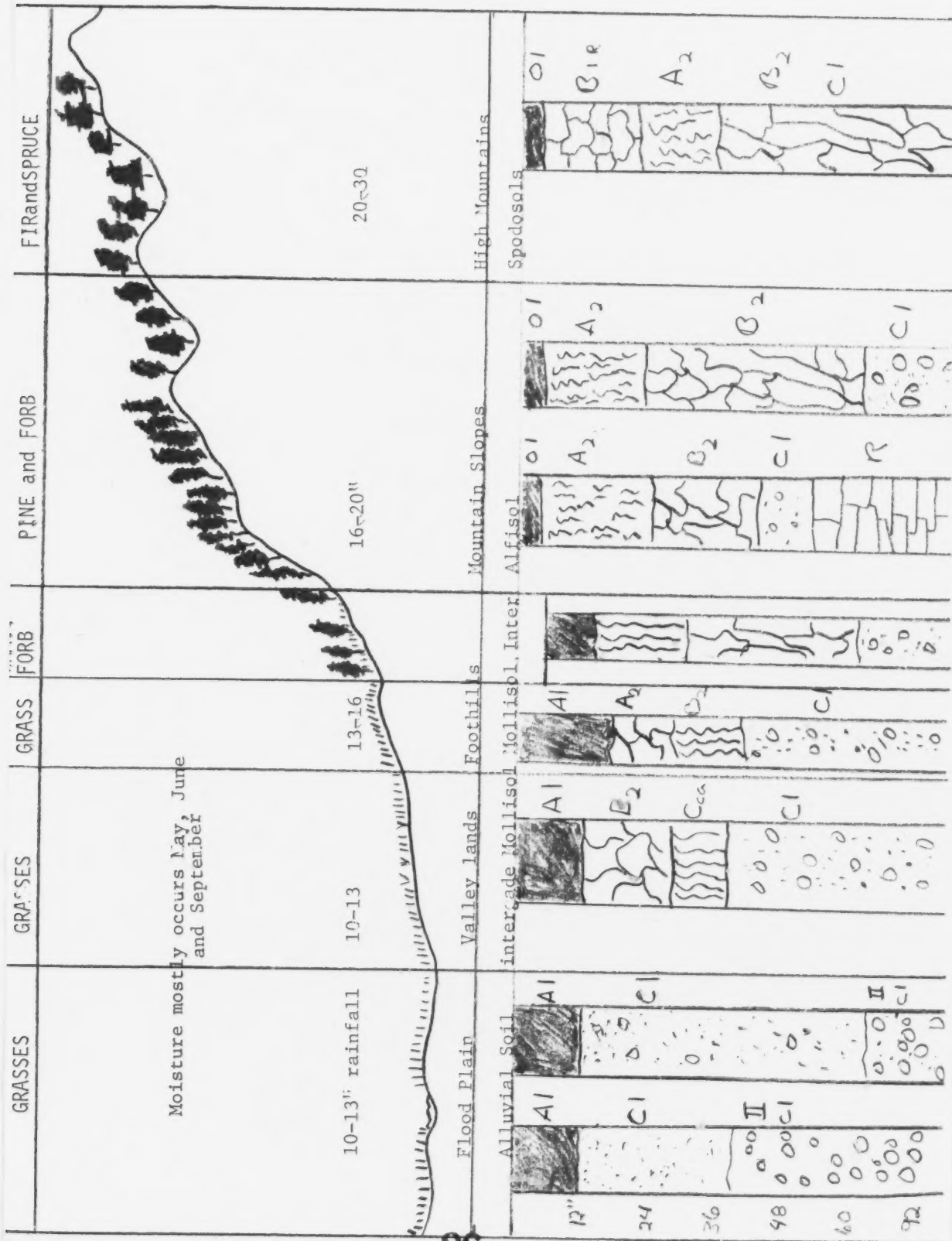
A horizon Maximum biological activity	Aoo	Litter, loose leaves & organic debris.
	Ao	Organic debris partially decomposed
	A	Dark in color; high in humus
B horizon Accumulation of suspended materials from above	B	Lighter in color maximum clay accumulation. Accumulation of materials leached from above. Leaching here may be quite high.
C horizon	Coo	Maximum accumulation of Calcium carbonate (hardpan). Usually on grassland soils. May or may not be present.
Weathered parent material — C	C	
D horizon	D	Bedrock

In general a soil has three function: 1) to support the plant, 2) to provide the plant with water, 3) to provide the plant with nutrients. A soil can be defined as that thin layer on the surface of the earth that is a living biological community.

A soil is named according to the development of the horizons that are found from the surface to the bedrock. Each of these areas or horizons is then given a name. The A horizon has the most abundance of biological life in it and the lower horizons are formed by the A horizon. Depending on the type of plant material found in the community there are different degrees and types of leaching and thus different soil profiles in each area.

The names given here are beyond the students' comprehension, but they are listed for the instructors' use.

In referring to the names of the soils on page 24 an alluvial is a soil brought in by water and has little development. A mollisol is a soil found on grasslands and has a deep A horizon and usually a C_{ca} horizon of calcium deposited before bedrock. An alfisol is characterized by a shallow A horizon and a gray A₂ and B₂ horizon. This soil is associated with a coniferous forest. A spodosol is a soil found in the Alpine regions and has a shallow A horizon and a B_{1r} horizon which gives the soil an iron or rust color.



PREPARATION FOR AN OUT-OF-DOORS ADVENTURE

The following, if read and discussed with the students, will better prepare them for their trip to outdoor areas.

1. The outdoors is a place to have fun. Making the outdoor experience "fun" and exciting for students of all ages is basic if they are to grow up with proper attitudes concerning renewable natural resources--soil, water, plants, and animals.
2. An awareness of nature. Around us, above us, under our feet, inside a seed or a pod or a tree trunk, at all times and everywhere--there are wonders to stir our curiosity and interest.
3. Reverence for life. The students should gain from their visits enough understanding of the outdoors to have a love and respect for all life forms, both plant and animal.
4. Plants and animals need each other. There is a continuing need to help students understand the world in which we live, and our responsibilities for it. This concept brings to light the fact that our lives are tied in with all other living and non-living things of the earth in a wonderful "web of life".

FALL ADVENTURE--The season when plants and animals prepare for winter.

The first day of fall is Septmeber 22. From this day until the first day of winter, days will become shorter and nights will become longer.

The sun's rays become more slanted as fall approaches. At noon the sun is no longer directly overhead as it was during early summer. You can now see your whole shadow if you stand in the sun at noon time.

The earth, wrapped in its thick blanket of air, still retains part of its summer heat, but day by day the earth grows colder. The sun's rays slant more and more. The cold season is approaching.

Most plants stop growing. Leaves on forest trees turn many colors--red, yellow, brown. They fall to the ground. As we walk through the woods, leaves crackle under our feet and give off a pleasant odor. In the field tall grasses, as tall as your head, turn brown. As they blow to and fro in the wind, they drop their seeds.

Seeds on other plants ripen and fall to the ground. Some blow away in the wind while others travel away on the fur or feathers of animals. We will look for some of these "hitch hiking" seeds in the outdoor areas.

Many insects, especially crickets and grasshoppers, will be singing and laying eggs. We may find a praying mantis or a walking stick.

Birds begin to migrate as fall approaches. Perhaps we will see large noisy flocks of migrating blackbirds. Others will be seen too, such as woodpeckers, blue jays, sparrows.

Furry animals such as chipmunks and squirrels are busy storing seeds and nuts. Others, such as woodchucks and mice build up a thick layer of fat to warm and nourish them.

Cold weather is not far off, but you can be sure that plants and animals will be ready for it.

SPRING ADVENTURE--the season of awakening after a winter of rest.

March 21 is the first day of spring. The days are becoming longer and the nights shorter.

The sun's rays are beginning to shine more directly toward the earth. They bring more warmth to the land and water. Your shadow is getting shorter in the noontime sun.

The cold winter winds begin to warm. Then comes the refreshing rain. The warmth and rain cause the sleeping seeds to "awaken". The hard coat on the seed softens and a baby plant inside begins to grow.

A faint greenness begins to appear on the trees, as tiny new leaves begin to unfold.

Some early flowering trees burst forth in full bloom. The woods may be sprinkled with snowberry blossoms.

Down on the forest floor a few early spring flowers begin to appear.

Insects which had been caterpillars in the fall come out of their cocoons changed into beautiful butterflies. Other insects also emerge and fly away to find food and lay eggs thus completing their life cycle.

Birds which had been enjoying the warm southern climate during the winter begin to return. They seek places to build new nests in which to lay their eggs. If you listen carefully you may hear their song or call.

The animals which have been asleep all winter begin to awaken. They are hungry and are eager to find food. Other animals begin to shed some of their heavy warm fur coats.

The woods become alive with activity as plants and animals awaken after a winter of rest or sleep.

FIELD SITES

The following is a partial list of the undeveloped field sites that are available in Powell County where you can take your students. At this time most of these areas that are described are in southern Powell County, but similar areas can be found elsewhere and the same types of studies can be done. As time progresses more and more of these areas will be described and put into your guide.

The types of studies that will be described here are aquatic, biomes, or communities, soil areas, fire burns, clear cuts, lake studies, pollution study areas, animal studies, range management, and geology studies. All sites that are listed have available materials in the center from which to do studies. A listing of the available kits in these areas is at the back of the book, but we encourage you to create your own studies as well.

THE CLARK FORK RIVER is probably the most diverse system that can be studied here in Powell County, but any stream can be studied.

The reason for the excellence of this stream is that it is the only industrialized classified stream in the state. The stream has extensive water pollution systems on it and becomes a fishable stream within 40 miles of the water pollution systems.

The closer one is to the Anaconda settling ponds the more drastic are the effects on the stream. Above the settling ponds the river is classified as industrial and no life will be found. Above and below the settling ponds makes a good comparison study as to what might happen without the proper environmental controls on industry. The settling ponds themselves are another excellent area to take students to show them the efforts that have been made by the Anaconda company. The center does have extensive information on the settling ponds and their operation.

If you are interested in studying pollution on the Clark Fork another study is a comparison between the Deer Lodge City Lagoon south of Deer Lodge and the Butte sewage treatment plant. The Butte plant personnel will take you on a tour of one of Montana's finest treatment facilities. Before visiting the city lagoon at Deer Lodge permission should be sought from the city.

At Garrison, another interesting comparison study can be made between the Clark Fork and the Little Blackfoot River. This is a study between a relatively clean stream and the Clark Fork. A study of the mouth of the Blackfoot as it enters into the Clark Fork reveals many interesting things.

One of the most interesting aquatic studies that can be done in this county is on Warm Spring Creek south of Garrison. This stream is a warm water stream which goes underground and then reappears. It has never been determined if that water which reappears is the same which enters the ground. Because of the temperature of the water and the fact that this area is high in limestone rock, there is a high percent of CaCO_3 in the water and forms interesting deposits along the stream as the water cools and the limestone precipitates out. The most spectacular of these formations is the Warm Springs Fall near the Cominco American mine.

All of these areas mentioned are excellent to study for all grade levels and contain many fascinating flora and fauna for children. Other types of studies that can be done which are associated are blackbird studies, and habitat development for water fowl.

Aquatic work is time consuming and several days should be planned in the class before entering the field and several days should be spent in the field as well as in the school on the follow-up work.

If any of these types of activities are planned, contact the Center for help and ideas along with equipment.

BIOME AND COMMUNITY STUDIES

Biome and community studies can vary from simply going with the student to observe what is found in nature to simple investigations, to rather complex studies involving much equipment.

Any area has its unique characteristics and can be studied. This includes a vacant lot in a city--a place often overlooked by the teacher.

Probably the easiest community for the students to go to would be that of the grassland. Here in the grassland students can do identification of forbs, grasses, small rodents, and insects. Soil studies can be done to determine the age of the stand as well as microhabitats.

The usual approach to an in depth study would be to sample the flora by some random method, a live snap trap study, a soil study, and abiotic studies including temperature, wind, slope, relative humidity and precipitation. All forms and equipment necessary for these types of studies are available through the Center.

Before one does any biome studies, be sure and contact the Center and we can give you much help with pre-field materials to prepare the students.

The other types of biomes that you will find in Powell County are Douglas fir, Lodgepole pine, Spruce fir and Alpine. There are also isolated stands of juniper, ponderosa, and larch. All of these areas can be found within a few miles of all of the schools in the county with the exception of the alpine and larch.

In all of the areas mentioned above, variations can be obtained by studying north vs. south slopes, river bottoms, and areas disturbed by man.

Land practices can be studied also in all of these areas--practices such as logging and road building, mining and farming. However, when studying such areas I would like to see you answer the following questions:

Why was it done?

Who did they do it for?

Was there an alternate way of doing it?

Because of the numerous sites that are available to do this type of work it is impossible to list them all here. Refer to the first of this book on the description of the county.

However there are several good sites that can be mentioned here and this area will be expanded as time passes.

An excellent north-south slope is found behind the Avon school. Extensive clear cuts can be found at Dog Creek, and also at Blizzard Mountain. All the alpine in the county is found in the Flint Creek range and the pure stands of sage brush (*Artemisia tridentata*) are found in the Avon-Helmville-Ovando area.

Range management studies are very important to the students of this county for it is the basis of our agricultural industry. The comparison studies are the best and can be found most everywhere in the valley. An excellent place to study is where a fence line divides a range and two different practices have been used.

Very little of the climax stands of the 19th century are in existence here in Powell County because of the effects of man, but there is one quite extensive climax area on the Emery road outside of Deer Lodge on the Bob Cowan range. This is an excellent area to take students in order to show them what the area was like before man changed it.

ANIMAL STUDIES

Animal studies can be done anywhere in the county depending on the type of animal that one is interested in. Here at Powell County High School the students have worked for several years on the Pronghorn Antelope and this material is available to help set up this type of study.

Suggested studies would be grasshopper migration, bird territoriality, mice habitats, and behavioral studies of almost any of the animals found in the county.

GEOLOGY

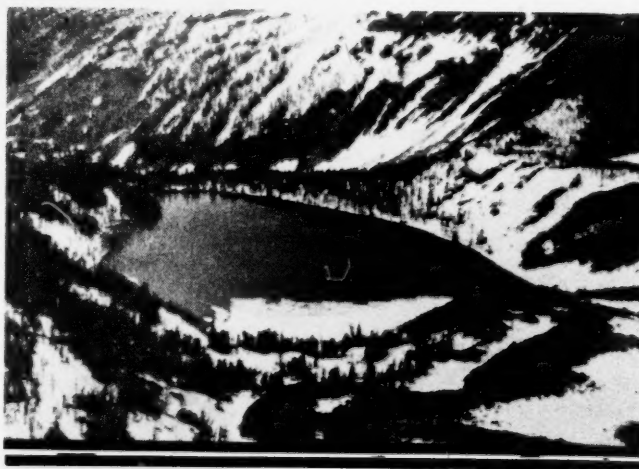
In the area of geology there are many areas that a teacher can take students. All three of the major rock types are found in the County and there is a tremendous amount of glaciation. There are many hanging valleys, terraces, moraines, and hills. One of the most excellent areas showing the effects of man can be found on the Tavenner Ranch and is visible from Highway 10 north of Deer Lodge. The foothills on the west side of the valley behind the veterinary clinic became saturated with water from the addition of water to irrigated fields on the flat above. This undermined the foothills and in one place several acres of land fell between 200 and 300 feet. This is an impressive area for students to view and study. In the future several investigations will be done in this area.

NOTE: In the outdoor development site section for specific detailed outdoor areas in geology where students can be taken.



(17) Much of the topography of Powell County has been formed by glacial action. This picture shows a typical glacial valley here in Powell County.

(18) These glaciers formed many high mountain lakes. The one shown in this picture was gored out at the cerix of the glacier.

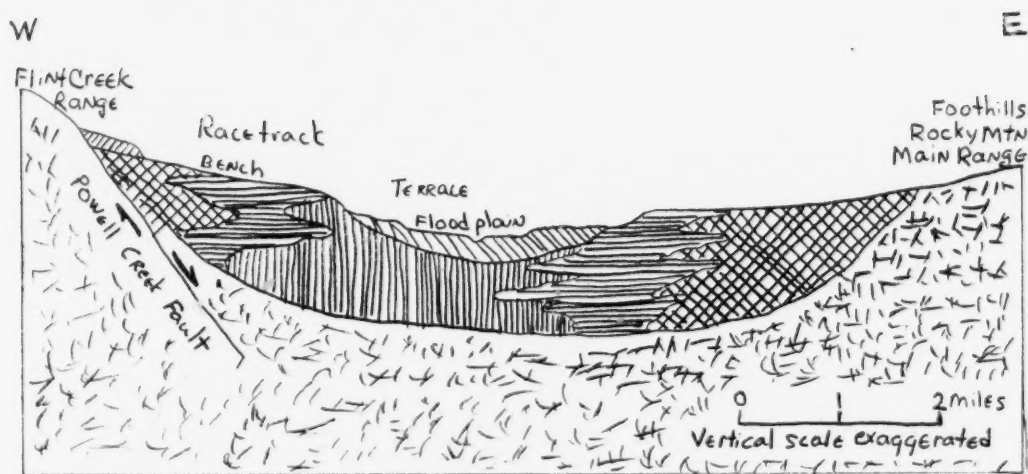


(19) This is the limestone terrace that has been formed over eons of time at Warm Springs Creek near Garrison. An excellent study site for students.

Geology Section: by Norman Jacobson

Geology of Deer Lodge Area

Activity 1



Composite diagrammatic cross section of Deer Lodge Valley

-  Quaternary Flood-plain
sill and terrace deposits
-  Quaternary glacial
moraine
-  Tertiary colluvium and
slope wash
-  Tertiary Flood-plain
sill
-  Tertiary channel sand
and gravel
-  Basement rocks
(granite, argillite, Quartzite
Schist)

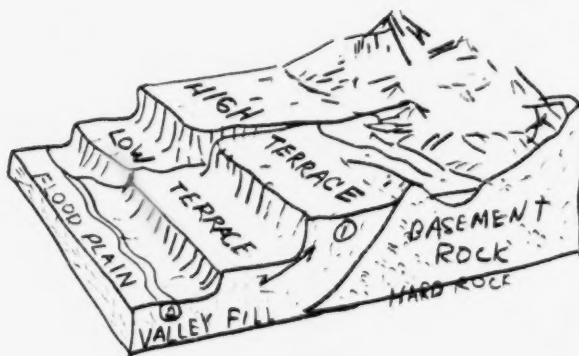
The Deer Lodge Valley is the center of a region of great geologic, topographic, and climatic diversity and is therefore ideally suited for a program in outdoor education. Our valley is a relatively high intermountain valley with an elevation of about 4500 feet that is located immediately west of the Continental Divide in west-central Montana. The valley is about 10 miles wide and nearly 32 miles long lying on a north-south axis that is drained by the Clark Fork River to the north. The valley is completely surrounded by mountains. The south and east

are bounded by relatively low mountains which are a part of the Boulder batholith with a maximum elevation of 8590 feet. These mountains consist mostly of lavas and pyroclastic rocks of Late Cretaceous to early Tertiary age and the granitic rocks are of Cretaceous age. Because these mountains are low, glaciation was limited to the eastern slopes since they would receive primarily the early morning sun which is generally not very warming. The more exposed western slopes which receives the afternoon insolation are eroded only by numerous small streams generally draining to the west into the Clark Fork River.

Geology of Deer Lodge Area continued.

The north is also bounded by low mountains, Garnet Range, whose maximum elevation is 7489 at the top of Mt. Baldy. That portion of the Range just north of the valley is part of the Garrison anticline, where much of the phosphate beds are either exposed or accessible to mining.

To the west and the south west are the rugged Anaconda and Flint Creek Ranges with the prominent Mount Powell rising to an elevation of 10,500 feet. These mountains are formed of igneous, metamorphic, and sedimentary rocks ranging in age from Precambrian to Tertiary. The metamorphic and sedimentary rocks have been intruded by granitic rocks of late Cretaceous or Early Tertiary age. They have been deeply glaciated and huge lateral and terminal moraines are extending out onto the valley floor.



① see Legend on sheet #1

② CLARK FORK RIVER

Diagrammatic section across east side of Deer Lodge Valley.

The most prominent features of the valley are the broad benches that slope gently from the mountains out on the valley floor. Most of the benches are underlain by sediments of tertiary age. The high terraces consist mostly of deposits of sands, gravels and silts from a variety of sources; ancient flood plains, glacial out wash and channel deposits. The lower terraces are composed primarily of sand and silts of glacial origin on the west side while those on the east side are of igneous origin.

Geology Section; Activity 2 ,

A Study of the Sedimentary Deposits at the Garrison Junction



Sedimentary rocks may be formed in three different ways; The deposition of sediments such as sand, gravel, and clays that have been carried by water, wind and ice, rocks of chemical origin such as limestone and organic rocks such as coal. The greatest percentages of sedimentary rocks are deposited under water and in horizontal layers or beds. Sedimentary rocks found in any other position have been subjected to some outside forces that have caused them to bend and or fracture. The road cut at the Garrison Junction has several stories to tell as you begin to study the out-cropping. There are several layers of semiconsolidated rocks that vary in composition, thickness, texture, hardness and color. These layers are also at an angle, seemingly cut off at the top with a layer of gravel covering them.

Some 100 million years ago these layers were being deposited under water, later to be covered by more sediments which began to compress the sediments into rocks. However, other forces began to twist and bend these rocks thus raising them above the surface of the water only to be subjected to the forces of weathering and erosion. This would explain the tilting beds and the top of folds being cut off. The coarser sediments found on top of these truncated beds would have been washed down from the hills to the north forming, what is known as an unconformity. An unconformity is a sequence of sediments that have one or more of its beds either partially or completely removed by erosion.

Garrison Junction Cont.

The approach to the study of this area would be to let the students describe in general terms what they see when looking at the whole road cut. The students should then examine the beds in detail to determine the difference in the beds in terms of composition and texture, why the beds maybe tilted, why they are cut off so evenly and where the source of the coarser materials might be.



Geology Section: Activity 3 ,

Glaciation in the Deer Lodge Valley

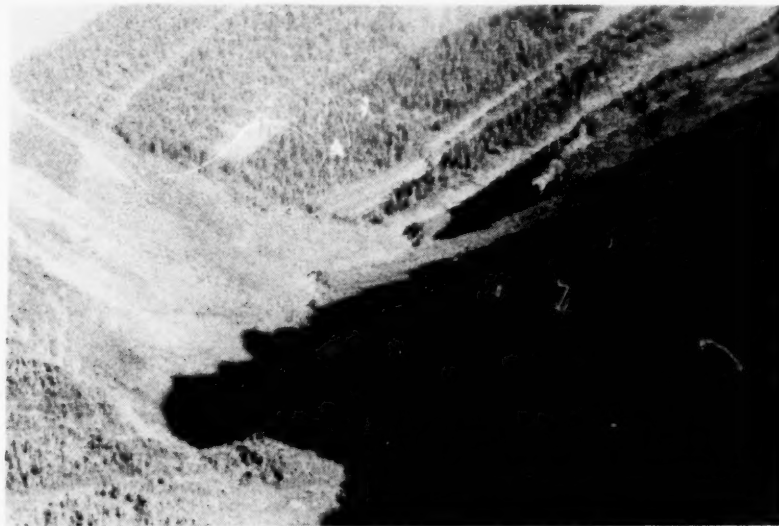


Glaciation in the Deer Lodge Valley is found primarily on the west side where four major glaciers, Race Track, Dempsey, Tin Cup, and Rock Creek, moved out onto the valley floor. Their huge lateral and terminal moraines extend up to 2 miles from their canyon walls and as much as 100 feet above the valley floor. These are the most recent glaciers and are believed to be of Wisconsin age. For several hundred feet above these moraines there is evidence of an older glacier that is often referred to as of Pre-Wisconsin age. The morainal material of the Pre-Wisconsin glaciers are more weathered and much harder to recognize than the more recent glaciers.



Glaciation Cont.

The Wisconsin Age glaciers are much easier to recognize because of the large numbers of many sized boulders ranging from several feet in diameter to a few inches. They consist mostly of granitic materials while the earlier glaciers had not cut so deeply into the Flint Creek Range and most of their moraines consist primarily of the surface rocks which were of sedimentary and metamorphic in origin. The amount of cover found on the different stages of glaciation is another way to separate the two. The more recent glaciers are relatively unweathered and poorly sorted, leaving them with little possibility of retaining what moisture they receive , and thereby generally unproductive. Therefore one finds few trees and very poor stands of grass. While the older glacial moraines have had more time to be weathered and eroded, there has been time for some topsoil to develop and we find much more cover present.



There are a numerous problems that the students could work on that would help them to develop an understanding of glaciers and glacial action. The following are a fes:

1. Compare one of the glaciated valleys to Baggs Creek or Cottonwood Creek on the east side of the valley. They could compare shape and gradient of the valley, size of sediments and to what extent the sediments have been sorted.
 2. Compare the Pre-Wisconsin glacial moraines to the later Wisconsin Glacial moraines.
 3. Determine if the Rock Creek and Race Track glaciers are of the same approximate age.
- Compare the percentages of igneous, sedimentary and metamorphic rocks found in the various moraines.

Geology Section: Activity 4 ,

Extrusive Igneous Rocks in the Emery Mine Area

The Emery Mining Area consists of numerous late Cretaceous lava flows that are located on the western edge of the Boulder Batholith. The country rocks throughout the area are lava flows consisting primarily of a basaltic composition. This lava was probably ejected from fissures and vents along a line east of here in the vicinity of Cliff Mountain. Eight hundred feet of lava flows have been measured at Cliff Mountain, however it is estimated that possibly as much as 2000 feet of lava may be found along the western margins of the area.

With the above as background the Emery area should be a good place to study extrusive igneous rock. Lava formed rocks, like all rocks, have essentially 2 characteristics--composition and texture.

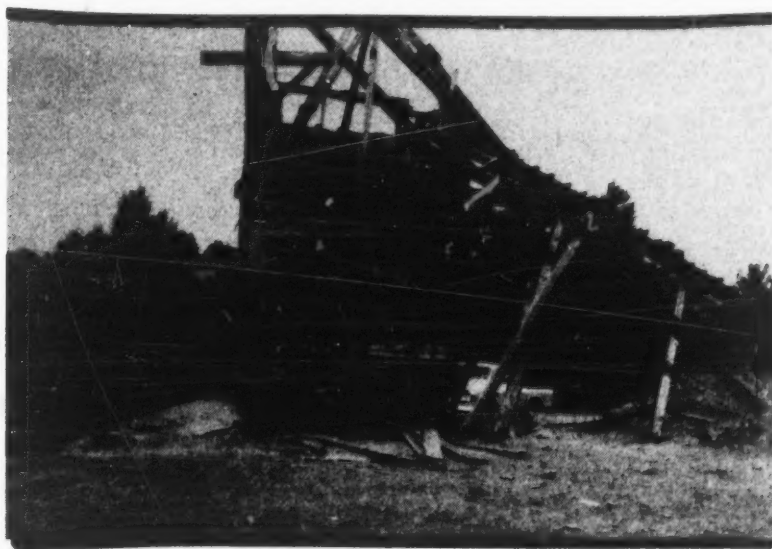


Composition is determined by the kind and amount of percent of mineral etc. in the rock, while texture is determined by the size, shape, and arrangements of the materials present. The basalts of this area are generally on the darker side, massive, blocky, sub-rounded boulder outcroppings. They weather to a dull brownish color, while a fresh break will tend toward a bluish-gray shade.

A field trip to Emery could begin by making your first stop just east of the Forest Service Cattle-guard in section 10. There is a pit below the road where a lot of earth and rock has

Emery Mine Area Cont.

been removed or the bank of the road cut is also a good place to collect basalt samples. Be sure to have them find weathered and freshly broken samples to compare. By using the map provided there is an easy round trip one can make with most cars. There are numerous outcroppings of basalt exposed along the way that provide excellent opportunities to compare color, composition, and texture.



An excellent place to study rock samples.



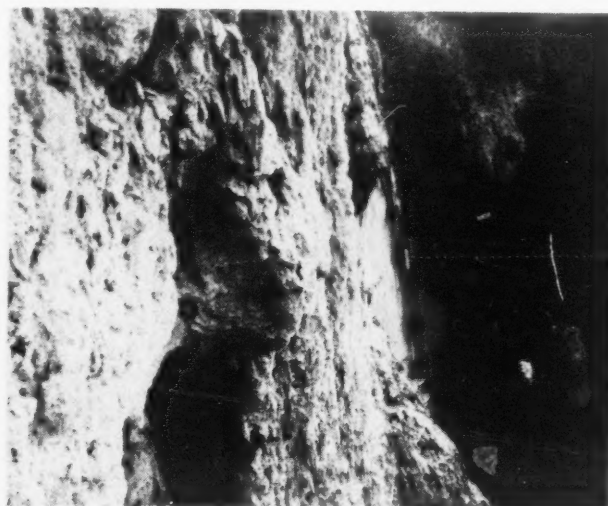
The Warm Springs Water Fall

As one drives up the canyon toward the falls it is possible to see the rows of trees and layers of rocks lying perpendicular to the creek and extending in what appears to be a large arc to the east and west. This arc like formation is called the Garrison Anticline. The creek draining this water shed has cut down several hundred feet through this formation.

As sediments begin to consolidate we find that many become much harder than others, these rocks are more resistant to weathering and erosion and therefore become what is often called "cliff formers". These are the ones that appear as pinnacles or outcroppings throughout the Deer Lodge Area.

Cliff formers are also responsible for the many waterfalls that occur. Next to the cattle guard above the falls there is a more resistant quartzite out cropping. This outcropping can be seen again on the east side as it emerges above the valley fill.

Since this area has both limestone formations and Hot Springs above the falls, it has a lot features common to Yellowstone National Park. The heated water dissolves the limestone above, carries it down stream just to be redeposited again as the water cascades over the falls below. This deposition will account for the leading edge of the falls being several 10's of feet ahead of the quartzite outcropping.



Warm Springs Water Fall cont.

The Warm Springs waterfall is made up of a series of terraces very similar to those found in the Mammoth Hot Springs area. However this build up is even more unique here because the limestone has been deposited around the stems of many plants. The precipitation of limestone in this area has been a very slow process since the stream is so small. Many of the encasements mentioned no longer have the stems in them because the wood has had time to decay, leaving just the hollow tubes. This creates an interesting problem for the students to solve.

In the area around the pools below the falls there is evidence of stalagmite and stalagtite formations.

There are several problems that can be given to the students. The first being: (1) Why is the waterfall located where it is? (2) Why isn't the waterfall in line with the quartzsite outcropping? (3) Compare this area to the Mammoth Hot Springs area. (4) and why are some of the terraces active and others not?

Geology Activity 6 ,

A Study of Sedimentary Rocks in the Bearmouth Area.

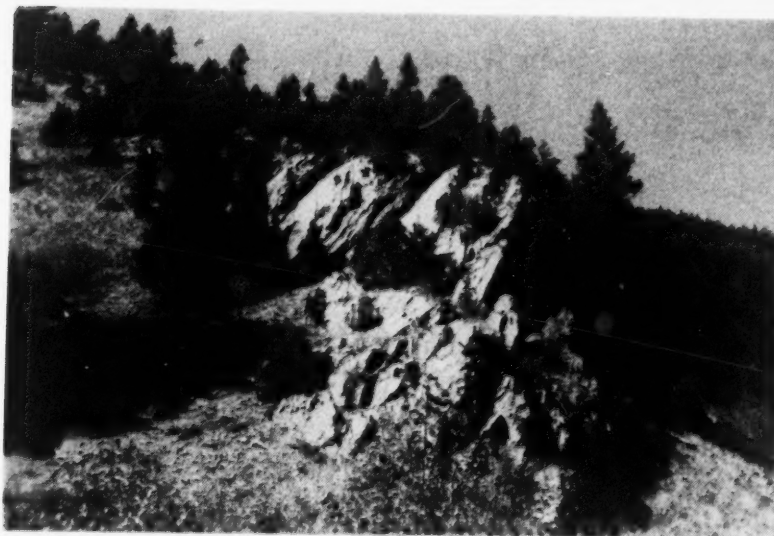
Sedimentary rocks in this area consists of approximately 2 miles of the Precambrian Belt Series, over a mile of Paleozoic rocks, and about one half mile of Mesozoic rocks and several hundred feet of unconsolidated Cenozoic sediments. As you drive these few miles up Rattler Gulch you will see one of the most impressive views of sedimentary rocks that you will find anywhere in the United States.



Bearmouth Area cont.

The origin of all the sedimentary rocks with the exception of the fossils, come primarily from the weathering of igneous rock. As the igneous rock are subjected to the forces of weathering certain products are formed. These products are sand, clays, water and various salts. Once these products are formed the various agents of erosion begin the process of sorting these sediments. The lighter and smaller the particle the farther it will be carried down stream. Ideally this is the reason we have such rocks as shale (clay), sandstone, and limestone etc.

This field trip has worded most successfully by giving the students a copy of the stratigraphy of the area or by using the publicat on "Geology of the Garnet-Bearmouth Area, Western Montana." The descriptions of the strata beginning with the Amsden Formation on page 34 can be easily compared to the actual strata along the road. By the time the students work their way up to the quarry they will have developed an understanding of the processes involved with the formations of the sedimentary rocks and will be ready to collect some interesting fossils that are easy to find.



-31k-

Bearmouth Area cont.

Rattler Gulch Area

0.0 Turn to north and proceed up Rattler Gulch road.

Note: Gravel road to south leads to loading ramp beside railroad tracks where excellent exposures of Jurassic and lower Cretaceous Kootenai Formation (mostly covered) for a mile or so. High on the west side of road the conical hill is composed of volcanic material, possibly the remnant of a small volcanic cone. Occasional volcanic rocks are also present in the Quaternary deposits along the road.

2.0 Outcrops of Jurassic Ellis Group and Permian Phosphoria Formation sediments (rare exposures), Quadrant Quartzite (tan weathering, on east side of road), and Amsden Fm. (red). Steep canyon walls ahead are in Madison Limestone of Mississippian Age. Dip of rocks here is almost vertical on southwest limb of Deep Creek Anticline. (See attached sketch).



2.3 Quarry in Madison Limestone.

2.5 Lodgepole Limestone member of Madison Limestone.

Bearmouth cont.

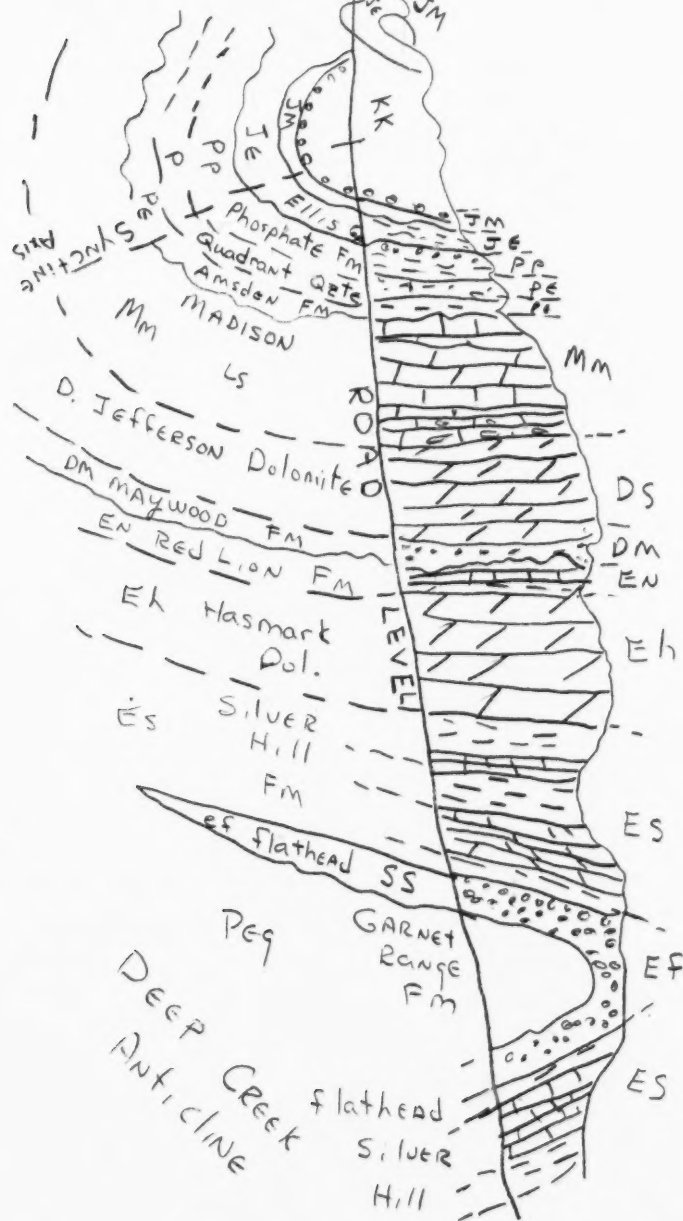
- 3.1 Jefferson Limestone (dolomite) on both sides of road.
- 3.5 Hasmark Dolomite high on ridge to west. The Maywood and Red Lion formations are mostly covered here except for scattered outcrops higher up on the canyon walls.



- 3.6 Approximate contact between the Hasmark Dolomite and the underlying Silver Hill Shale (mostly covered). Blocks of limestone in the float from the Silver Hill contain trilobites and Girvanella algal structures. The prominent dark colored limestone outcrop ahead is in the lower part of the Silver Hill. The beds beyond are covered, but sandstone blocks, probably Flathead Sandstone, can be found in the alluvium on the canyon slopes.
- 5.2 Schiffman sawmill junction.

Mulkey
Gulch
Syncline

Clark
Fork
JM

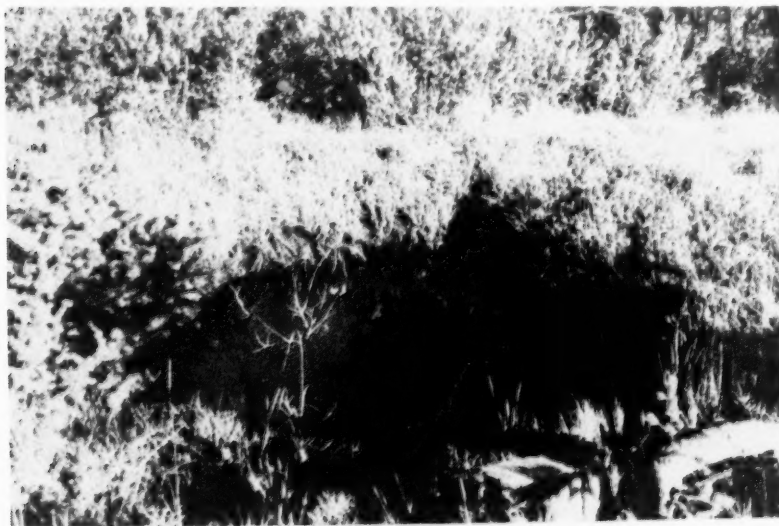


RATTLER
GULCH AREA SKETCH

Geology Section: Activity 7 ,

Determining the Origin of the Lock Hart Meadows.

If the students are aware that the rate of sedimentation is determined by the size of the sediments involved, and have a basic idea of the development of a soil profile, they will be ready for this field trip. With this as background, the students should be taken to the spring near the source of North Powderhorn Creek just east of Champion Pass. (see the attached map.) While at the first stop the students should be assisted in identifying the actual process of assortment and sedimentation taking place. As these processes are discussed the idea of temporary base level should be introduced and stressed throughout the remainder of the study.



The second area to be studied is down stream a few hundred yards where a number of beaver dams in various stages of pond succession exist. Here, recently constructed beaver dams can be compared to ones that are so old that only rows of willows remain. It is here that the students can see the processes of assortment and deposition taking place on a very large scale compared to that found at the spring. This is also a good time to point out such concepts as plant succession, vegetative

Lock Hart Meadows cont.

reproduction of the willows and the effect too much water has on some types of plants.



When you have completed this section, the students should be taken to a point overlooking the large meadow. From this vantage point observe a small meandering stream, the headwaters of the Boulder River, intersecting the various vegetational patterns which have established themselves on top of the channel deposits of the ancient meandering stream.



Lock Hart Meadows cont.

The final stop is the eroded outlet of the old lake bed. Here the students can summarize the major points of the field trip: assortment, deposition, base level, meandering and plant succession. While standing on top of the lateral moraine, they should be able to visualize the small valley glacier moving out onto the meadow forming a temporary dam that stopped the flow of the Boulder River some 10 to 15,000 years ago.



-31r-

Geology Section: Activity 8 ,

Landslides

Landslides, mudflows and creeps are various forms of mass movements that occur on sloping terrain. In all cases the starting force for these movements is gravity. The nature of the mass movement is controlled by the type of materials found in the area, the amount of friction that exists between these materials, particularly clay sediments, and the angle of the slope over which the mass is moving.

Masses of land at rest do not move without some cause; they are set off or triggered by some condition that has effected the balance that had been established. The triggering events that commonly cause mass movements on a hill side are:

- (1) Earthquakes such as the one in the Quake Lake area,
- (2) Under cutting by erosion, such as rivers,
- (3) Various types of alterations of the natural conditions by man, such as road building and housing projects, and
- (4) Increasing amounts of water being added to the soil following heavy rainfall or when the soil is being irrigated as is the case in ones study of this slide area.

There are many examples of landslides in the valley. They are found along the edges of the terraces bordering the Clark Fork River. The recent ones are most probably the result of increased amounts of water due to irrigation that is seeping into the different clay beds. As the water is absorbed by the clays it begins to act as a lubricant and it becomes very fluid. If any of you have been on the road to the Champion Pass after a heavy rain you are well aware of what water does to the clayey soils on the surface of the ground on the east side of the valley.

As one approaches the slide area he will notice the extra sediments in the stream bed, many trees will be leaning in every direction with many of their tops now pointing straight up, and the ground will have a wave like appearance in many areas. When you are in the slide area you will see where the ground literally dropped some 30 odd feet indicating that a tremendous amount of



Landslides cont.

subsoil must have moved out from under the surface. The cross sections exposed on the east and west sides of the slide area have excellent examples of differential sedimentation including gravels, sands, silts, and clays; cross bedding; and is capped by several feet of glacial outwash.



The field trip has been successfully operated by letting the student collect data on their own to describe the events that took place.

SCHOOL LABORATORIES IN POWELL COUNTY

INTRODUCTION--During the past fifty years the United States has become a predominantly urban nation, both in thought and in physical character. Large and middle-sized communities, many within complex urban regions, have evolved to where over seventy per cent of this country's population resides on one and one-half per cent of the nation's land surface. By 1980 eight out of ten Americans will probably live in an urban environment. Consequently, the independent rural-oriented living that once characterized this country's social and political heritage is no longer a dominating influence in the lives of most Americans.

Within Powell County the Powell County Environmental In-Service Curriculum Center services seven school districts and the high school. An outdoor environmental learning area has been set up within each community. These learning areas range from a grassland to a forest to a pond. A set of independent geology sites will also be set up.

A detailed description of each of these areas will be found on the following pages. Both biotic and abiotic features of the areas are listed as well as pictures to give the students and teachers a better idea of what each area looks like. In addition to the descriptions and pictures a short film on each lab has also been prepared.

It was our original thought to publish separate booklets for each of the area. By printing them all together however, each teacher has access to all the outdoor labs in the county.

Only a teacher's copy of this book is being produced but the Center will provide student sheets consisting of pictures and descriptions of the areas so that the teacher can familiarize the students with an area before taking them there. The pictures and descriptions for the students will be printed on separate pages so that the teacher can hold back the description page if he wishes and the students can write their own description of the area as a field exercise.

Following the descriptions of the areas are a variety of activities that the teacher can do with the students as field activities.

All activities will be keyed to age level and to the field area where they can be done. The key for the areas is as follows:

Avon-----A	Garrison (gold Creek)--G
Deer Lodge----D	Helmville-----H
Elliston-----E	Ovando-----O

Many of the activities found in the book may be varied and improved upon by you the teachers. We at the Center encourage this. We ask that as you develop ideas you send them to us so that we can in turn print them and add them to the manual.

We have included only one copy of the field sheets for the students because it is impossible to print enough of the right ones to fill your wants. By providing you the teacher with a copy, you can either make your own like it or use it as a master sheet in making ditto copies with a 3M copy machine. If you do not have a 3M copy machine we can provide you with ditto masters when you need them.

THE PHILOSOPHY BEHIND THE USE OF OUTDOOR ACTIVITIES

ENVIRONMENTAL EDUCATION IS AIMED AT PRODUCING A CITIZENRY THAT IS KNOWLEDGEABLE CONCERNING THE BIOPHYSICAL ENVIRONMENT AND ITS ASSOCIATED PROBLEMS; AWARE OF HOW TO HELP SOLVE THESE PROBLEMS; AND MOTIVATED TO WORK TOWARD THEIR SOLUTION.

The above expresses what we are trying to achieve. We are concerned about giving our youth activities and experiences that will motivate them and help them to solve environmental problems as they arise in their lives. This involvement with the environment may be as specific as studying the "microclimates, fire, and plant production in an Illinois prairie" to as simple as being a housewife buying the right types of products and voting as an environmentally aware citizen.

We feel that some of these objectives can be met in the classroom and the occasional outdoor activity, but we feel the actual setting up of an environmental area which has been catalogued can provide many of these activities and experiences in such a way that no other program could ever do.

All of the activities found in this book meet the following requirements. Any subliminal activities that you develop should also meet with these requirements.

1. THE ACTIVITY INVOLVES THE LEARNER IN THE ENVIRONMENT.
2. THE ACTIVITY IS RELEVANT TO THE LEARNER IN TODAY'S WORLD.
3. THE ACTIVITY INCLUDES OPPORTUNITIES FOR PROBLEM SOLVING.
4. THE ACTIVITY INCLUDES OPPORTUNITIES FOR THE LEARNER TO COLLECT AND RECORD DATA BASED ON HIS OWN OBSERVATIONS..
5. THE ACTIVITY INCLUDES OPPORTUNITIES FOR THE LEARNER TO MAKE HIS OWN INTERPRETATION ABOUT THE DATA HE COLLECTS.

The following page is a guide for collecting field data for environmental problem solving.

GUIDELINES FOR COLLECTING DATA FOR ENVIRONMENTAL PROBLEM-SOLVING

DEFINING THE PROBLEM--What problem or issue is involved? Define the nature of the topic to be investigated.
What do we want to find out about this problem?

DATA COLLECTING-----What kind of data needs to be collected?
Which places are available for data collecting?
What methods are available for collecting this data? (Visual observation, testing equipment for biophysical data, past records, etc.)
Which methods would be most appropriate?
How can this data be recorded in a manner that will provide for significant interpretations? (Tables, charts, graphs, written observations, maps, sketches, etc.)

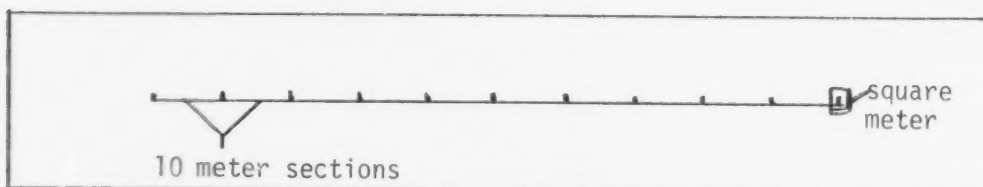
DATA INTERPRETING-----What comparisons, contrasts, or cause-and-effect relationships can be inferred from the collected data?
What big ideas are suggested by the interpretations of this data?
What implications do these big ideas have to environmental management?

EXTENDING THE INVESTIGATION--Which parts of the investigation can be explored more fully by further data collecting?
What further data needs to be collected?
Where? How often? What time of year?
Of what significance is this new data to the investigation?

DESCRIPTION OF OUTDOOR ENVIRONMENTAL AREAS

The following pages are a description of the outdoor areas. All areas are systematically described so that they can easily be compared to one another. We hope that you will eventually develop other sites so we are including the procedures used to describe the areas and the site analysis forms for each site.

PLANTS--Two methods are used for the sampling of plants. The first method is the meter square system which gives not only the % of each plant species, but also the % of the ground cover. In the meter square system three items are needed--1) a square meter which is made by joining the ends of four meter sticks to form a square; 2) a long string of a given length (100 meters); and a recording sheet to put all gathered data on. To use this system follow example No.1 by placing the meter square on the ground each 10 meters and recording the number of times every plant species occurs within the square and the total % of ground cover for all plants.



EXAMPLE NO. 1

The second method for sampling plants is the line transect method where only a string of a given length (10 meters) is needed in addition to the data sheet for recording. Stretch the string out straight. Starting at one end of the string, proceed the full length counting the number of times each plant species occurs under the string. For both methods the % of each plant per given area can be calculated by this formula:

$$\frac{\text{total number of each species}}{\text{total number of all plants}}$$

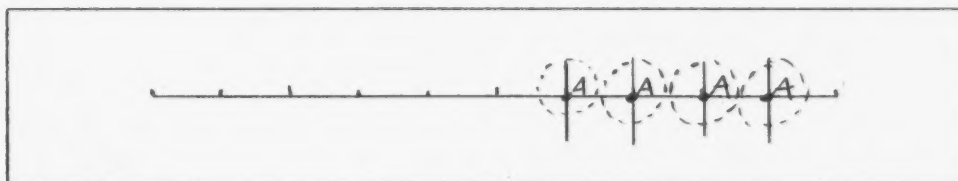
The more samples that are taken, the more accurate the final percentage.

TREES--Two systems are used for sampling trees--the random sampling method and the quarter quadrant method. In the random sampling method a straight line of a given length (100 meters) is needed. This line is subdivided into shorter lengths of 10 meters. One person proceeds down the line to each 10-meter station where with arms outstretched, picks the nearest tree on each side of the line. After determining which trees are the closest, the distance between those two trees, the diameter, and the age are all recorded for each tree. See Example No. 2.



EXAMPLE NO. 2

The quarter quadrant method also need a straight line of a known length (100 meters) which is divided into equal lengths of 10 meters each. At each station make a line perpendicular to the longer line so there are four equal sections. This is done ten times in a section of 100 meters. Decide which tree is the closest tree from point A in each section and record the distance from point A, the diameter (DBH tape), and the age (increment bore) for each tree. See Example No. 3.



EXAMPLE NO. 3

ANIMALS--Sampling of animals is done by several different methods. There are live traps, snap traps, scat samples, tracks, and visual observation--all are commonly used. Insects are sampled by sweeping the foliage in the area to be sampled with an insect net.

THE DEER LODGE OUTDOOR ENVIRONMENTAL AREA

GENERAL DESCRIPTION--The outdoor area for the Deer Lodge region is found east of Deer Lodge on the Emery road at an elevation of 7000 feet. The area is found on private property belonging to Billy Applegate. The area is unique in many aspects. To begin with, the area was chosen because it is a north-south slope with considerable contrast as noted by the photographs accompanying this section. The south (north-facing slope) is a forest hill of a slope of about 45 degrees and is made up of predominately Douglas fir with some nine bark understory. The substory or floor of the forest is rather bare and devoid of any vegetation except for the Arnica cordifolia. This is a typical forest floor made up of alfisols. (See soils.) This is a rather moist area and a large amount of decomposition is taking place on the floor and many logs can be seen in different stages of decay. This contributes to many mosses, lichens, mushrooms, and other decomposers. Other plants found within the forest are false solomonseal and a fine Clematis columbiana.

At the bottom of the hill is a seasonal creek which flows from May to late July. This stream shows evidence of erosion and the looseness of the soil. This might also be an excellent area for a soil profile.

Moving to the other side of the stream on the north (facing south) slope a new kind of environment begins. Again there is the Douglas fir but it is more scattered or in isolated groups. Along the stream is a stand of Populus tremuloides. Moving up the hill there is a variety of grasses and forbs including Idaho, Mule, Rough and June Grass. In the forbs there are blue flax, several varieties of penstemon, bluebells, camas, violets, shooting stars, lupine, larkspur and oregon grape. The most obvious difference is the lack of Douglas fir and the predominance of Balsamorhiza sagittalis and Antelope bitterbrush. There is also a large number of Juniper which has been highlined or nearly killed out by wintering deer. The evidence of the deer is also quite evident by scat also. Moving higher away from the stream the trees and bitterbrush falls way to a few isolated Ponderosa and scattered Douglas fir which are found only in rock outcroppings. The community has changed now to a short grass community with its associated forbs. An occasional grouse and many song birds are in this area as well.

For a better preview of the area look at the maps of the area showing vegetation types and relief. Also refer to the pictures of the area. The pictures of the area are also available in student number. A film (super 8) is available on this area. This can be used as a review, introduction or test.

Refer to the site analysis sheets for the detailed descriptions of this area.

CHOICE OF LOCATION--This area was chosen by the Center for use because it is close enough to the schools for maximum use, but more importantly it is one of the better sites in the valley for comparison studies between north and south slopes.

Essentially the two slopes receive the same amount of moisture, but the amount of available moisture for the two areas is quite different. This is of course related to the sun light and the direction of and amount of radiant energy received. The south facing slope receives the most radiant energy and thus the temperature is higher and the relative humidity is lower then on the south slope. This abiotic feature is reflected in the plant life and soil character.

Basically many of the studies that can be done on many of the other areas can be done here and in addition many comparison studies can be done.

Comparison studies can be done assuming that the following information is true.

1. the amount of annual precipitation is the same for both areas
2. the geological source of the area is the same for both
3. the amount of solar radiation is different on the two slopes.

Thus the following abiotic factors are different;

- a. temperature
- b. relative humidity
- c. soils
- d. soil moisture

And the biotic factors of a) animal life and b) plant life also differ.



Typical dense Douglas fir forest
on the north slope.



Occurrences like this fire-scarred tree
can be used to good advantage--a good place to develop hypothesis.



South slope has less trees and
more brush such as this ante-
lope betterbrush. Notice the
the use by deer & the clubbing
effect on the branches.



Trees on the south slope are found
only in rock outcroppings



What could have caused this?

How could you find out?

Code to maps

The topography map is based on a 10 foot interval

Plant map

Gromwell-Delphinium-Artemisia frigida-

Bitterbrush-Balsamorhiza-

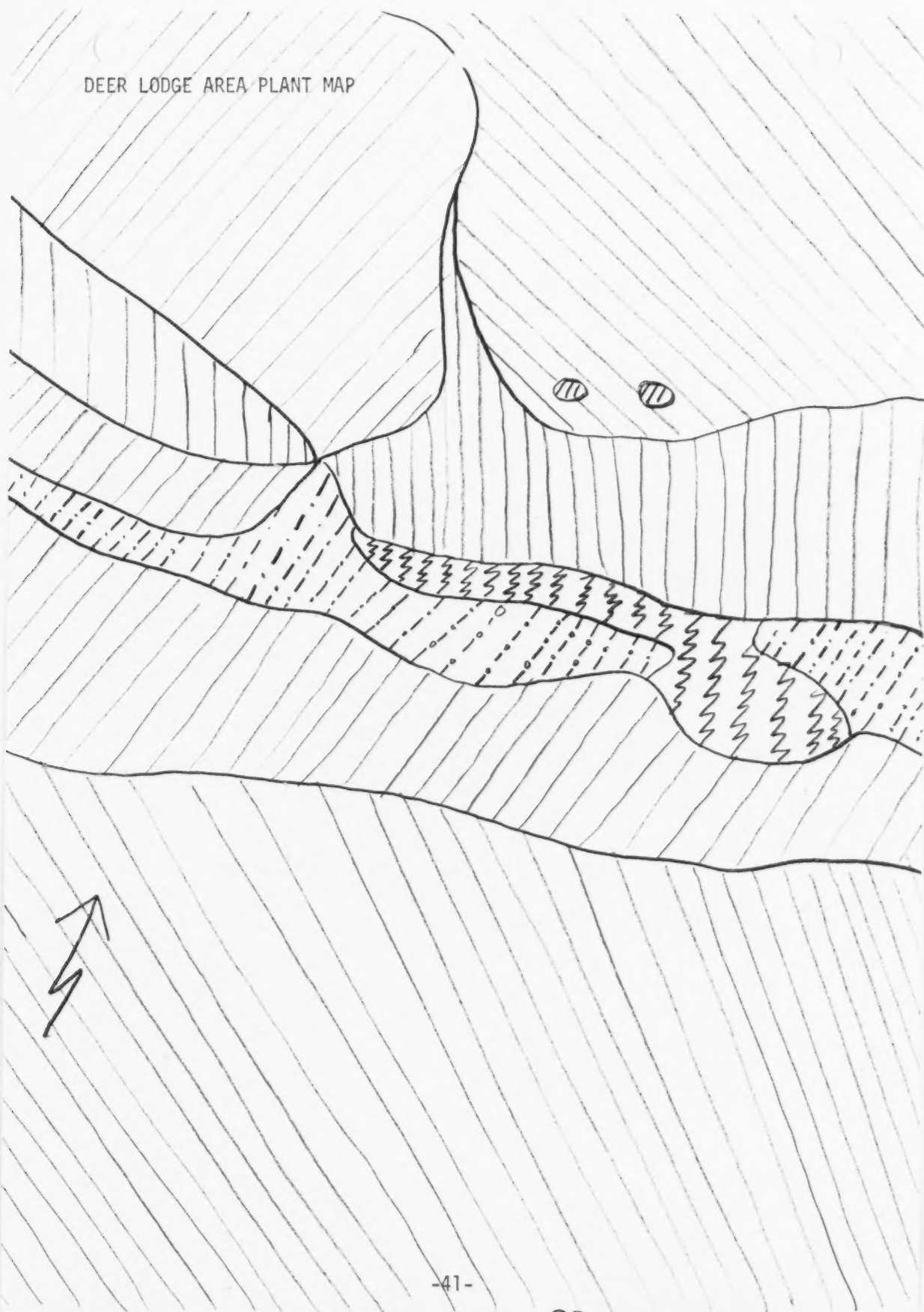
Douglas Fir-

Populus tremuloides

Viola-



DEER LODGE AREA PLANT MAP



Topography Map



SITE ANALYSIS FOR DEER LODGE OUTDOOR LAB

COMMUNITY NAME: Douglas fir side hill
 LOCATION: Emery (Deer Lodge)
 ELEVATION: 5,100 ft.
 TERRAIN: Hillside facing north
 COVER: 80%
 WATER: One small creek
 ASSOCIATED VEGETATIVE SPECIES: Senecio, Achillea, Artemesia,
 Frigida, Fragaria, Mahonia,
 Grindelia

BOTANICAL DATA: Trees and Shrubs		Forbs	Grasses
Douglas Fir		Geranium-3.7%	no data
Rose--2.1%		Phlox--21.2%	as they
		Gromwell-2.8%	have gone
			to seed
			for this
			year.
			70.0%

ZOOLOGICAL DATA: Mammals		Birds	Insects	Fish
Deer		Magpie	Grasshopper	None
Elk		Sparrow	Mosquito	
Chipmunk		Robin	Fly	
Squirrel		Hawk	Beetle	
Fox			Bee	
Bear			Gnat	
Coyote			Ant	

GEOLOGICAL DATA: Rock Type--Basalt
 Weathering--Quite a bit, good break-down
 Soil Origin--Volcanic
 Type--Sandy-loam
 Depth--Ao-1"; A-3"; B-9"
 Development--very good
 pH--5½
 Moisture--Dry-fresh
 Streams--one small stream
 Channel Trends--lateral cutting

THE AVON OUTDOOR ENVIRONMENTAL AREA

GENERAL DESCRIPTION--This site is found behind and to the north of the school and is within easy distance for all the students.

This area is on private property belonging to Earl Knight. The area seems to be an extrusive igneous basalt. On the map it is with the line formed by the Boulder Batholith and the rock type appears to be the same. Because it is extrusive, the slope of the hill is extremely sharp and the soils are very loose. The extrusive rock is eroding at a very fast rate and the small gravel is the type of soil found in the area and there is no horizontal development in the soils at all. Because of the looseness of the soils some care has to be taken with young students, but it does not represent a dangerous situation. At the bottom of the hill the soils begin to develop and a good study can be done as to the development of soils and why the best soils are found at the bottom of the hill.

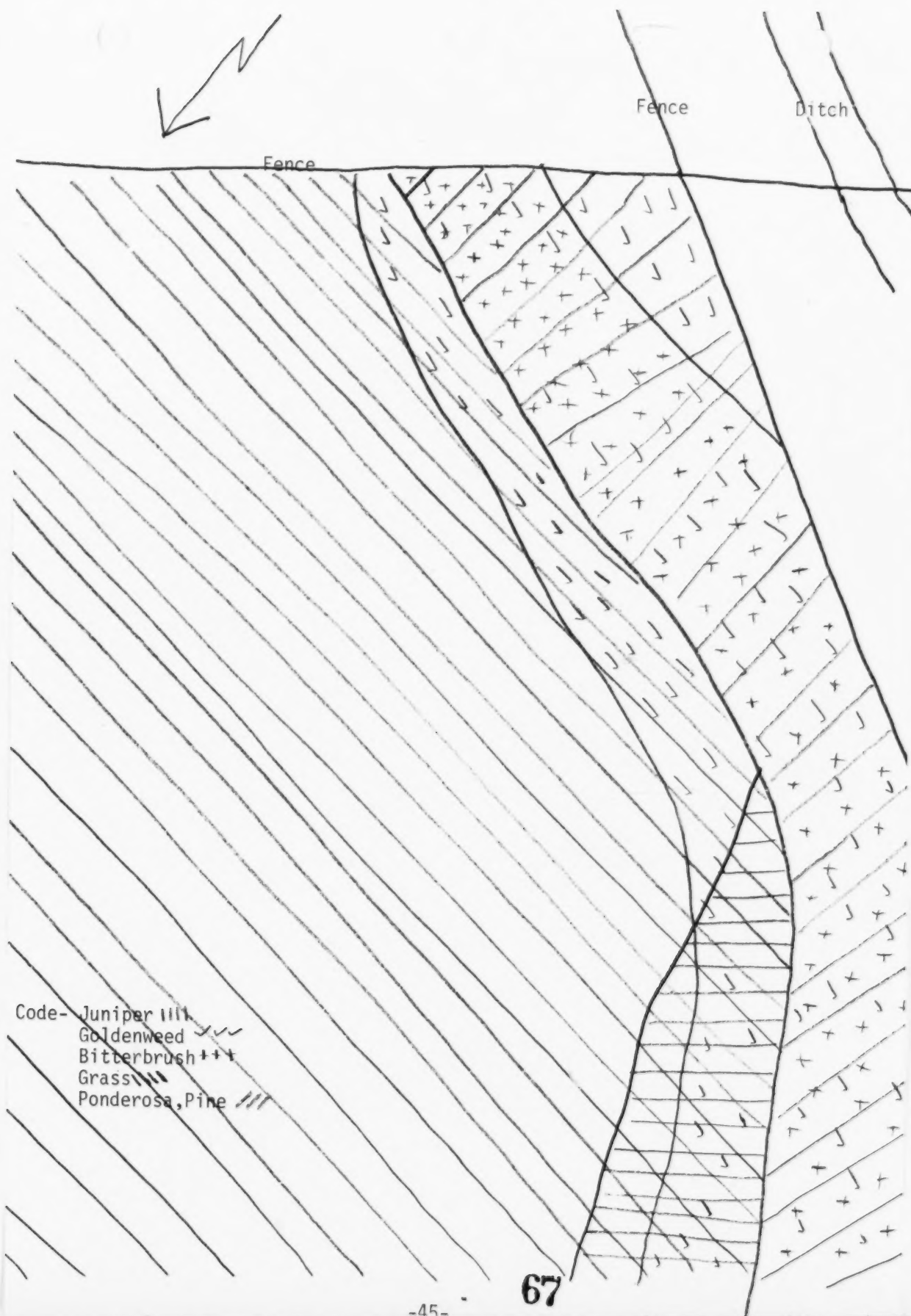
By having fair soils at the bottom of the hill a comparative study can be done between good and bad soil sites. Found within this area of colloval soils deposited by the hill are lupine, anternareia, gromwell, potentillia, yarrow, strawberry, scarlet mallow, flax, etc.. Higher on the hill away from the deeper soils are bitterbrush, ribes, rose, and antemesia frigidea.

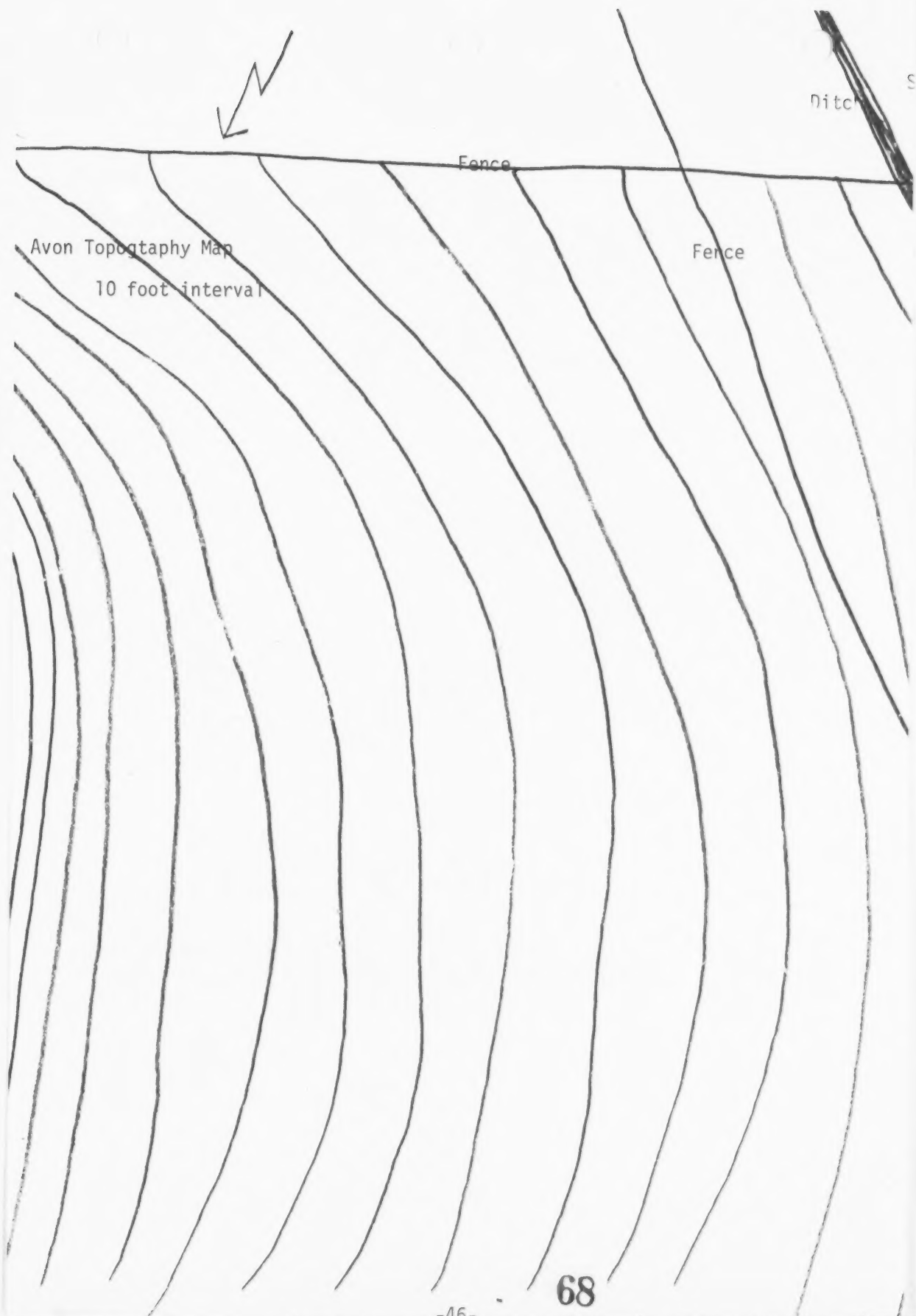
The Avon forest site differs from the Elliston forest site in that at Avon the soil is undeveloped and at Elliston there is a well developed typical soil. The Avon site is made up of Ponderosa, Douglas fir and Juniper. The Juniper shows a great deal of high line and the stand is of uneven age. Several of the large mature trees are dead and this would be a good area for discussion with the students.

This area seems to be the best area for animal studies. It is a winter range area for the mule deer, and there is a good deal of activity from the small rodents such as chipmunk, golden mantle and squirrel. These activities should be capitalized on as much as possible. This is also a good area for birds including the upland game birds such as grouse. There are many ground nest (such as sparrow (lark) in the area.

The Avon-Elliston teachers should get together and jointly use the two forests as they represent two extremes in forests.

CHOICE OF LOCATION--This site was chosen for it is close to the Avon school and represents a forest that is of recent origin. Photographs of this area as recent as 1910 show no trees on the slope. This can be directly related to the lack of true soil on the slope. It was also chosen because of its winter range for mule deer and several studies can be done with these animals.







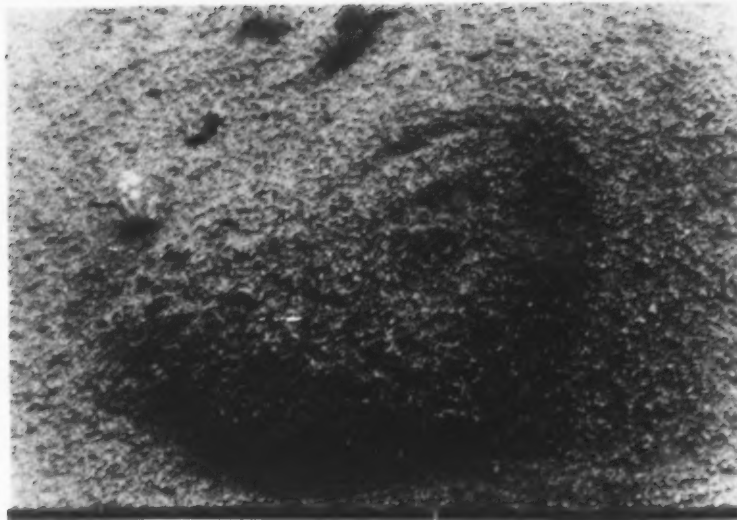
The stand at Avon is a mixture of both Douglas fir and Ponderosa pine.



The slope is steep and dry.
There is little understory.



A dead tree always makes
a good study. What hap-
pened? Why?



The soils are a loose gravel, little developed.



Decay: Is it necessary in the forest?

SITE ANALYSIS FOR AVON OUTDOOR LAB

COMMUNITY NAME: Dry rocky hillside
 LOCATION: Avon
 ELEVATION: Bottom of hill--4,800ft.; top of hill--5,000 ft.
 TERRAIN: Dry rocky hillside facing south
 COVER: Very little cover--20% in grassland; 5% in trees
 WATER: Irrigation ditch

BOTANICAL DATA:	Trees and Shrubs	Forbs	Grass
	Ponderosa pine	Goldenweed-41.1%	Cheat
	Douglas fir	Yarrow-----7.8%	grass
	Juniper	Onion-----1.9%	29.4%
	Bitterbrush-13.7%	Potentilla--1.9%	
	Artemesia----3.9%		

ZOOLOGICAL DATA:	Mammals	Birds	Insects	Fish
	Deer	Robin	Mosquito	None
	Other	Sparrow	Fly	
	Chipmunk	Magpie	Butterfly	
	Rabbit	Crow	Grasshopper	
	Squirrel	Hawk	Tick	
	Packrat		Beetle	
	Gopher		Gnat	
			Bee	

GEOLOGICAL DATA: Rock Type--Igneous extrusive
 Main Minerals--Basalt; several small outcroppings
 of other materials
 Type of deposit--Volcanic
 Topography--25%
 Exposure--South
 Soil Origin--Volcanic
 Type--small gravel, very little soil
 Depth--0
 Development--Colluvial Inceptisol
 pH--6
 Moisture--Very little
 Streams--One irrigation ditch; no streams
 Channel trends--no definite cuts, but it would
 appear to be downcutting

ASSOCIATED VEGETATIVE SPECIES: Rubus, Rosa, Chrysothamnus

ECOLOGICAL DATA: Successional Observation--New doug-fir moving
 down hill, a few new
 shoots of bitterbrush
 Proposed Climax Species--Plant--Doug fir & Bit-
 terbrush
 Animal--Deer & Insects
 Suggested Biome Name--Dry, rocky, south-facing
 slope with small grassland

THE OVANDO OUTDOOR ENVIRONMENTAL AREA

GENERAL DESCRIPTION--The outdoor area in Ovando is found northwest of the school across the road. It is approximately 500 feet from the back of the school. The area has the largest diversity of plant communities of any of the areas. It is located on private land belonging to Mr. Bertilson.

Looking at the map and referring to the pictures notice that the environment changes from dry to wet. Next to the road there is a small coniferous forest consisting of Ponderosa pine and Douglas fir. This gives way to a deciduous forest of Quaking aspen. This forest surrounds the south and north sides of the pond and is within 50 feet of the pond at all times. To the south of the deciduous forest we find an intermediate grassland of wet species such as tragopogon, aster, clematis, geranium, iris, snakegrass, and clover. This cover is nearly 100%. Moving further west of this area the elevation rises and one moves into a lower available water area and a typical range grassland consisting of June grass, blue bunch, Idaho fescue, rough fescue, green needle and cheat grass is seen. These two areas next to each other give a good comparison study of the difference water makes in an area. This same sequence is found on the north-west side of the pond as well only the area is much larger and expands into the rest of the field. This is an excellent area to work with the spring flowers for with this variety almost all of the early bloomers can be found here.

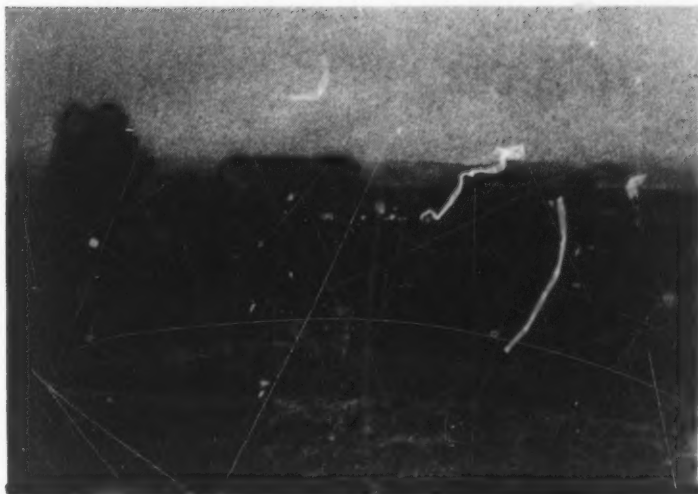
Looking at the pond itself, it is a shallow pond with a deep mud bottom and has many emergent plants surrounding its banks. This type of pond is ideal for it represents little danger for children and has a large variety of algae and protists in it.

CHOICE OF LOCATION--This area was chosen by the Center for use because it is close to the school and more importantly it is an area of large variety in plant types.

In general this area can be treated as an area of decreasing available moisture as one moves away from the pond. Thus, all plant life and in turn animal life can be related to the amount of moisture and many interesting studies can be done considering this fact.

Types of studies that could be done here include 1) comparison between plant types; communities 2) mouse studies, 3) bird studies, and pond studies.

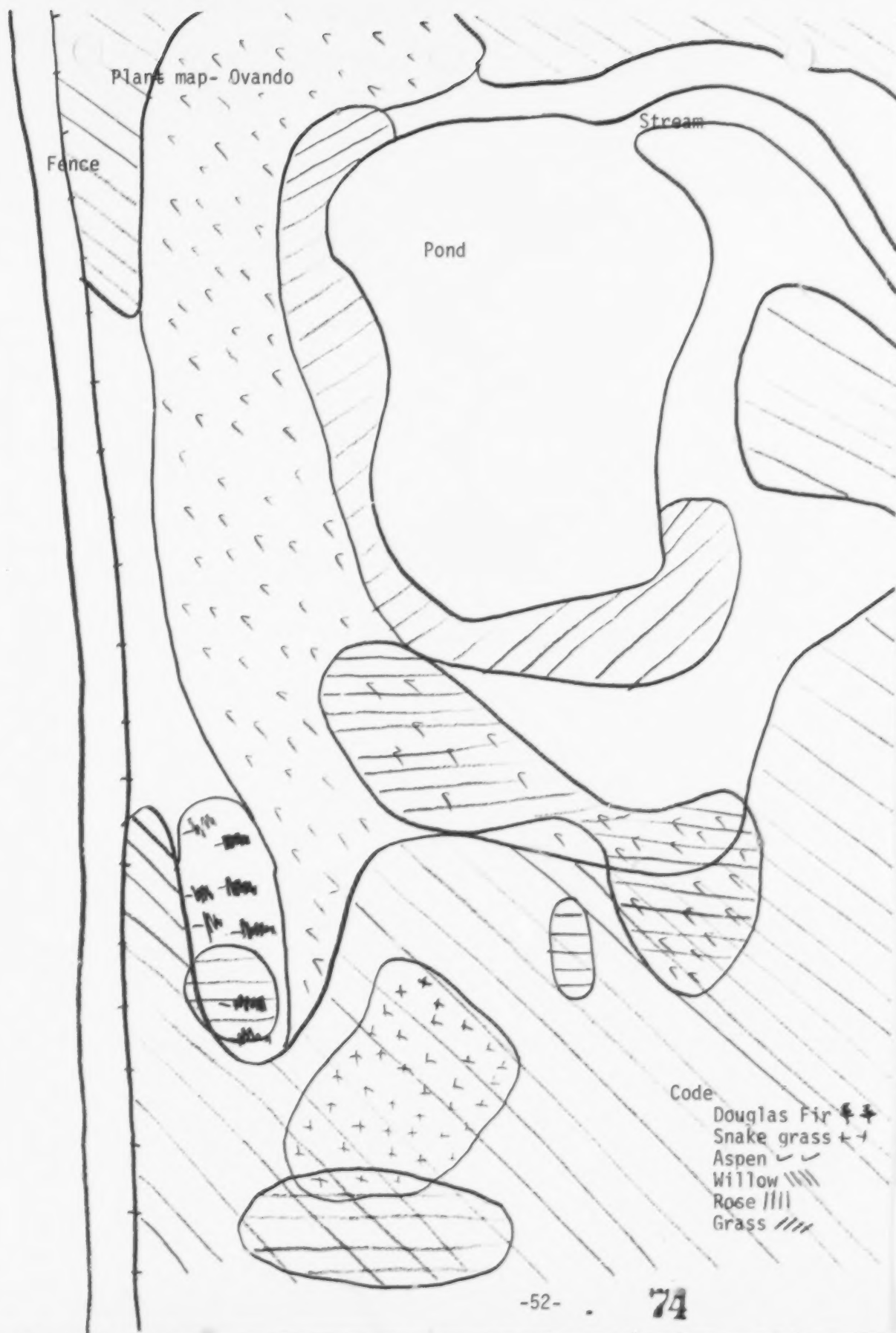
The pond on the Ovan-
do site. A shallow
pond with plants e-
merging--an excellent
place to find aquatic
organisms.

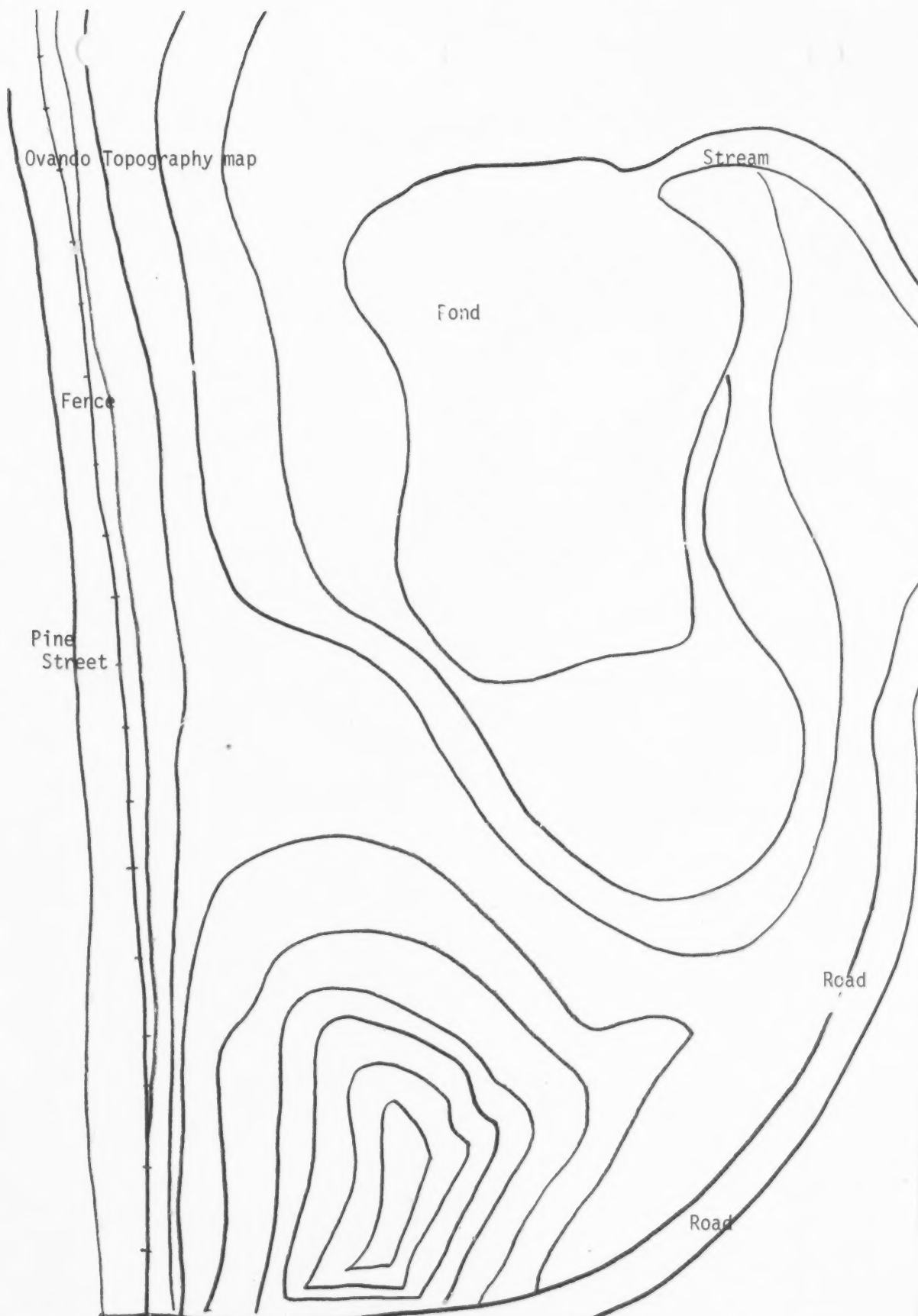


Looking down from the
dry hill to the wet
meadow. Behind the
meadow is a mixed
stand of poplar and
Douglas fir.



Notice how the fir is
dominant over the pop-
lar. Why?





SITE ANALYSIS FOR OVANDO OUTDOOR LAB

COMMUNITY NAME: Transition zone
 LOCATION: Ovando
 ELEVATION: 4,200 feet
 TERRAIN: low rolling hills
 COVER: 90%
 WATER: Pond and creek
 ASSOCIATED VEGETATIVE SPECIES: Linum, Brassica, Antennaria, Potentilla, Aster, Clematis, Mertensia, Iris, Taraxicum, Ranunculaceae, Vicia, Agoseris, Lomatium, Dodecatheon, Stellaria, Orthocarpus, Gailardia, Delphinium, Anemone.
 CLIMATE: Summer--hot; Winter--cold.

BOTANICAL DATA: Trees and Shrubs-

Douglas fir	
Ponderosa pine	av. diam. 11½
Quaking aspen	7.88 rings/inch
Fringed sagebrush	8.6%

Forbs

Dry Hillside	Intermediate	Meadow
Goldenweed 23.3%	Lupine 17.1%	Yarrow 5.9%
Lupine 2.4%	Yarrow 2.1%	Clover 1.4%
Gromwell 1.2%	Goldenweed 2.1%	Thistle 4.4%
	Gromwell 8.5%	Geranium 1.0%
	Goldenrod 5.3%	Snakegrass 1.1%
	Milkweed 4.2%	
	Clover 1.1%	
	Geranium 4.2%	
	Sunflower 3.2%	

Grass

Dry Hillside	Intermediate	Meadow
63.2%	28.8%	81.0%

ZOOLOGICAL DATA: Mammals Birds Insects Fish

Deer	Red-winged	Mosquito	
Rabbit	blackbird	Fly	
Fox	White-breasted	Gnat	
Muskrat	swallow	Bee	
Weasel	Mallard duck	Beetle	
Chipmunk	Meadowlark	Spider	
Gopher	Song sparrow	Butterfly	
Squirrel	Tree sparrow	Ants	
	Savanna sparrow	Dragonfly	
	Vesper sparrow	Mayfly	
	Robin	Horsefly	
	Sparrow hawk		
	Woodpecker		
	Kingfisher		

GEOLOGICAL DATA: Rock Type--Sandstone
Weathering--Good, Quite a bit and some areas have
many rocks and others have almost no
rocks at all
Type of Deposit--Stream alluvium
Topography==5-10%
Exposure--West-Northwest
Soil origin--Alluvial
Type--Clay, sandy loam
Depth--Ao-3"; A-9"; B-10"
Development--Very good
pH--7
Moisture--Dry-fresh
Soil Temperature--90°F
Streams--One creek
Channel Characteristics--2 feet wide, quite slow
Channel Trends--Meandering with marsh all along
the sides

ECOLOGICAL DATA: Successional Observation--The pond is gradually
filling in.
Proposed Climax Species--Animal-Deer and insects
Plant-Aspen and grass
Suggested Biome Name--Conifer and deciduous forest
with pond and grassland

THE GOLD CREEK-GARRISON OUTDOOR ENVIRONMENTAL AREA

GENERAL DESCRIPTION--The area for use as an outdoor environmental area is a dry NE hillside directly behind the school at Garrison on the northwest side. This area has enough moisture to support only a grass-land community, but because it is a north exposure the evaporation rate is not as great and the area is able to support a Juniper stand also with a substory of bitterbrush and broom snake grass. This area does not offer the variety of the other areas but in the spring of the year before the dry season, the hill does yield a good variety of forbs.

The most important attribute of the hill is that at all times it hosts a variety of birds and this can be developed into a meaningful study.

As is the usual case, the soils at the bottom of the hill have been deposited from the rest of the hill and are quite different than those on the upper reaches of the slope and this can also be developed into a study.

Plants to be found at the bottom of the hill are phlox, golden-weed, tragapogan, vetch, and spotted knapweed. Grasses in the area are bluebunch wheatgrass, cheat and green needle. Farther up the slope these give way to Juniper, apple, rose, bitterbrush, broom-snake grass, and fringed sage.

Because of the Juniper trees in the area many microhabitats can be found under the trees and these can be developed into studies.

There is evidence of tree death caused by the Garrison phosphate plant and these might be looked at and studied by the students. If this is done it will be found that the trees of both Douglas fir and Juniper are dead on the side that faces the plant but living on the side away from the plant.

CHOICE OF LOCATION--This study site does not offer the variety that some of the other sites offer but the Center is in hope that the schools will use each others sites. This is a very good site in terms of its availability to the students of the two schools and it will also be the bases for a good comparison if used in conjunction with any of the other sites.

NOTE: It is due to the size of the Gold Creek school that a separate outdoor lab was not set up there at this time.



In this picture you can see the juniper stand. This is the only outdoor area that has an extensive stand of juniper. The berries of these plants are eaten by birds and makes an excellent area to study birds.

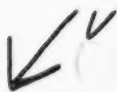
Fence

Fence

Code
Juniper + + + +
grass
Tragapogon
Bitterbrush
Vetch

-58-

80



Elliston Outdoor Area
Topography Map

SITE ANALYSIS FOR GARRISON OUTDOOR LAB

COMMUNITY NAME: Dryland hillside
 LOCATION: Garrison
 ELEVATION: Bottom on hill--4,400 feet; Top of hill--4,500 feet
 TERRAIN: Dry rocky hillside facing NE
 COVER: Out of trees--70%; In trees--30%
 WATER: None
 ASSOCIATED VEGETATIVE SPECIES: Malva, Gaillardia, Polygonum, Opuntia
 Balsamorhiza, Linum, Grindelia,
 Melilotus, Achillea

BOTANICAL DATA:	Trees & Shrubs	Forbs	Grasses
	Juniper		
	Apple	Phlox-----16.6%	Bluebunch
	Rose	Goldenweed--5.2%	Cheat--36.7%
	Bitterbrush	Tragopogan-32.4%	Green needle
	Fringed sage--2.6%	Vetch-----17.5%	
	Broomsnake---11.4%	Spotted	
		knapweed--2.6%	

ZOOLOGICAL DATA:	Mammals	Birds	Insects	Fish
	Deer	Robin	Mosquito	None
		Sparrow	Fly	
		Canary	Gnat	
		Hawk	Bee	
		Bluebird	Butterfly	
			Beetle	
			Ants	
			Spider	

GEOLOGICAL DATA: Rock Type--Limestone
 Main Minerals--Calcium
 Weathering--Several areas show water as the greatest element in weathering.
 Topography--Small grassland and hill rising 100 feet
 Type of Deposit--Glacial outwash
 Topography--25%
 Exposure--NE
 Soil origin--Glacial
 Type--Clay and gravel
 Depth--4 feet topsoil; 160 feet bedrock
 Development--very little: A- $\frac{1}{2}$ "; B-1"; C-14"
 pH--7 $\frac{1}{2}$
 Moisture--Dry
 Streams--None, several dry gulchs

ECOLOGICAL DATA: Successional Observation--New Junipers moving down the hill along with only several new clumps bunch grass
 Proposed Climax Species--Plant-Juniper, Bitterbrush
 Animal-Insects, deer
 Suggested Biome Name--Dry rocky hillside & grassland

HELMVILLE OUTDOOR ENVIRONMENTAL AREA

The outdoor area is found southeast of the school. It is literally the back yard of the school. This area is completely different from any of the areas in that it is a dry site of little variety. In itself, this area might not offer the student a great deal of study potential, but if you tie this in with the Ovando site which is not more than 18 miles away a great deal can be learned about the different types of communities found in the northern end of the county.

This area is rather small and at a first glance it looks like a mono-culture of sagebrush. This is the large sage, called *Artemisia tridentata*. This is different from the Deer Lodge area of the county where this plant is not found, but rather the large sage looking plant found is Rabbit Rubber Brush, *Chrysothamnus nauseosus*. As one looks at the area closer and more at the lower plants you will find a large variety of forbs which are covered by the sage. These plants include sedum, tragapogon, lupine, sweet clover, Delphinium, gromwell, bitterroot, yellow bell, phlox and many others. Most of these flowers are in bloom by the end of the school year.

Because of this seemingly mono-culture community which is really not the case this is an excellent area to teach students about sampling methods.

At the upper end of this area is a large igneous rock which appears to be an erratic. The interesting thing about this rock is the types of lichens that can be found on it. Many interesting discussions can be done on the formation of soil from rock. A movie is available on this from the center that can tie in quite well.

Micro-habitats can be studied as one moves out from the rock and the different sides of the rock will show you different plant types. A good place to show the effects of sunlight on the environment is at this rock as well.

A hydrothermograph recording of the Helmville area taken during the summer months is shown on the next page to give you an idea of what can be done.

CHOISE OF SITE--This area was chosen for its closeness to the school and also so that a comparison can be made with the Ovando site which is a wet site and contains none of the *Artemisia*. I hope that the two northern county schools would interchange information and the students of the two schools study both sites.

Types of studies that can be done here are soil, bird, plant, insect, and soil formation, mapping.

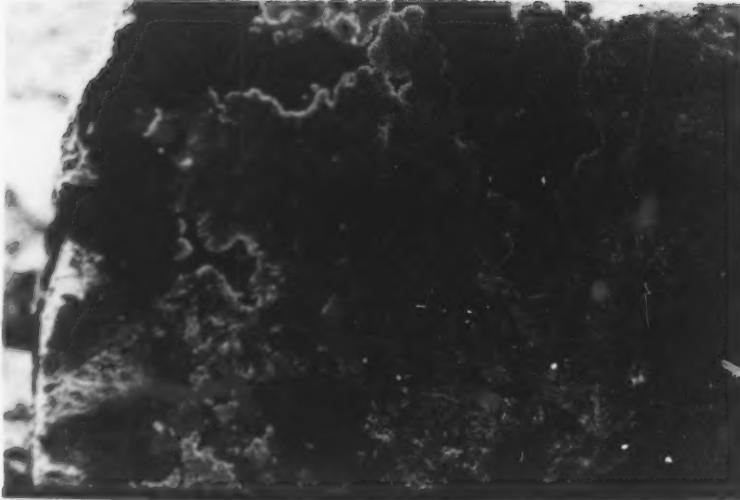
Notice how the Artemesia dominates over the other plants.



Here is a close up of the sage. Notice the three clefts on the leaves.

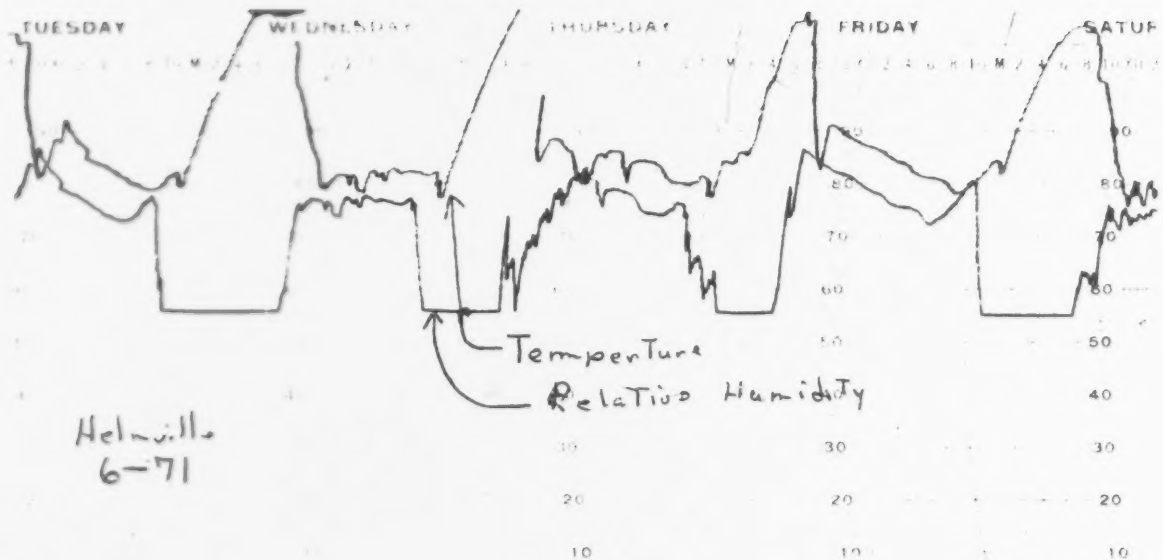


In the middle of the Area a large rock is found. Could different plants be found on different sides of it.



Notice the lichens.
What is the role of the
lichens in nature.

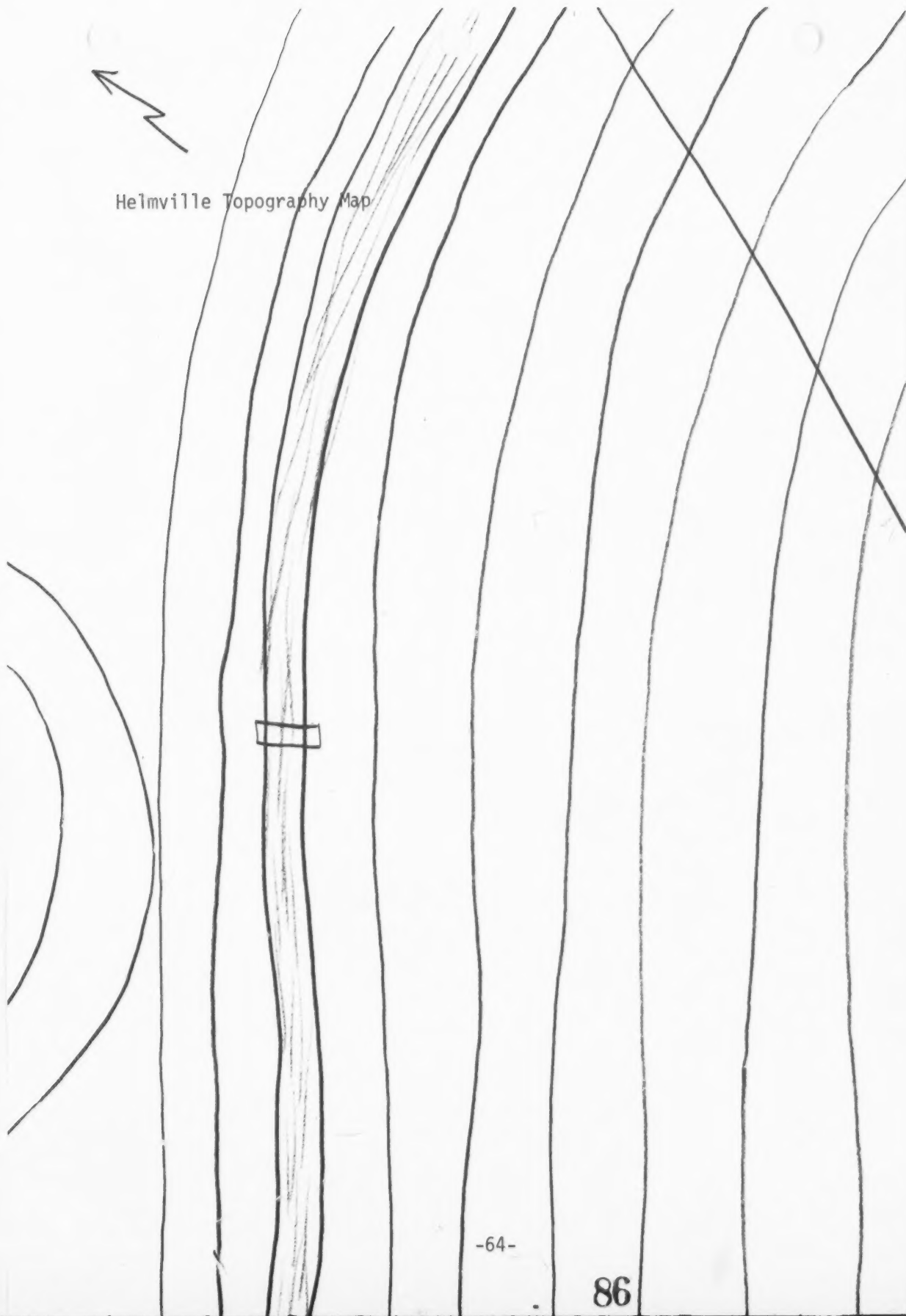
HYDROTHERMOGRAPH



TAYLOR INSTRUMENT COMPANIES ROCHESTER N.Y. U.S.A.



Helmville Topography Map



Code
Sweet Clover-
Grass-

Rose-

Gumweed-

Sagebrush, Lupine, Vetch-

SITE ANALYSIS FOR HELMVILLE OUTDOOR LAB

COMMUNITY NAME: Sagebrush sidehill
 LOCATION: Helmville
 ELEVATION: 4400-4475
 TERRAIN: North facing even hillside
 COVER: 60%
 WATER: None
 ASSOCIATED VEGETATIVE SPECIES: Sedum, Tragopogon, Delphinium, Stellaria
 Gromwell, Lewisia, Fritelaria, Aster, Castilleja,
 Achillea, Phlox, Agoseris, Antennaria, Senecio,
 Balsamorhiza, Trifolium, Lomatium, Anemone
 Climate: Summer-hot, Winter- cold

BOTANICAL DATA: Trees and Shurbs-

Big Sagebrush	75.0%
---------------	-------

Forbs

Sweetclover	7.5%
Lupine	7.5%
Vetch	5.0%
American bistort	2.5%

Grass

total	2.5%
-------	------

ZOOLOGICAL DATA:

Mammals	Birds	Insects	Fish
Deer	Magpie	Mosquito	
Rabbit	Crow	Bee	
	Sparrow	Fly	
	Robin	Gnat	
	Hawk	Beetle	
		Spider	
		Ant	

GEOLOGICAL DATA: Rock type -- Shale, limestone
 Main Minerals-- Calcium, clay
 Type of Deposit- lake bottom
 Topography-- 12%
 Exposure-- North
 Soil orgin-- Alluvual
 Type-- clay-sand
 Development-- very little
 pH- 7
 Moisture- very little
 Streams- one irrigation ditch
 Channel trends--none

SITE ANALYSIS FOR HELMVILLE OUTDOOR LAB

ECOLOGICAL DATA:

Successional Observations- A few new sagebrush plants

Proposed Climax Species- Plant- Sagebrush

Animals- small rodents- insects

Suggested Biome Name- Very Dry and hot sagebrush sidehill
facing north

THE ELLISTON OUTDOOR ENVIRONMENTAL AREA

GENERAL DESCRIPTION-- This outdoor area is on private ground leased by John Irwen and is not as close to the school as some of the other sites but is close enough so that it should be used considerably by the school.

The site is located southeast or directly across the highway from the school. This area is very large and consists of a dry grassland blending into a populous forest which blends into a coniferous forest of Douglas fir and lodgepole, with a few juniper between the deciduous and coniferous forest.

One of the basic principles in ecology is the way that water and available precipitation is related to the plant types. Nowhere have I seen a more booklike site than that of the Elliston site to show this principle. Notice that in the beginning of this book there is a diagram (24) of the elevation and plant communities that are related to the elevation. You can see all this at the Elliston site. You start with a dry grassland or the representative plant types except for the fact that it has been grazed heavily by livestock. Within this area you will find many forbs and a considerable amount of Idaho fescue. As we climb in elevation we come into the popular stand with an understory of juniper, rose and ribes. Moving up from here we get into the typical mixed age stand of Douglas fir with a few lodgepole pine. This is a fairly wet forest, due to the direction of exposure, and has many associated forbs such as arnica, strawberry, and Claytonia. This area has a lot of mushrooms, mosses, lichens, fungus, and algae.

The types of studies that can be done here are endless and are left only to the imagination of the teacher. These would include comparison studies, density studies, plant identification, soil, mapping, increment bore studies, and tree identification.

CHOICE OF LOCATION-- This area was chosen because of its booklike appearance as one of the communities gives way through an ecotone to the next community. Other than not having a pond, this area gives us one of the largest varieties that we have.

Note!

SE 014 422

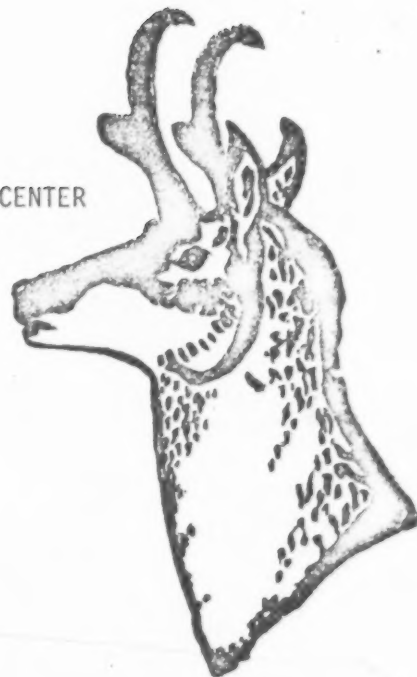
rec'd 12/18/72

POWELL COUNTY ENVIRONMENTAL IN-SERVICE CURRICULUM CENTER

709 Missouri Avenue Telephone 406 846-2757
Gary D. Swant, Director

DEER LODGE, MONTANA 59722

December 11, 1972



Cheryl L. Fuller
ERIC Information Analysis
Center for Science, Mathematics
and Environmental Education
1460 West Lane Avenue
Columbus, Ohio 43221

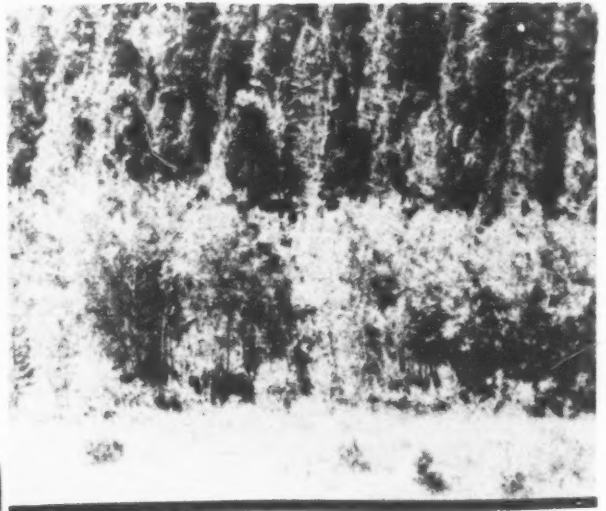
Dear Mrs Fuller,

Pages 70 and 71 are not present in the book, A Field Guide to Outdoor Learning in Powell County, because of a typographical error which occurred in the numbering of the pages. We decided to put the book together as printed instead of wasting paper.

I hope you now will be able to proceed with your review. If we can be of any further service please do not hesitate to ask.

Sincerely,
David C. Pugsley
David C. Pugsley
Assistant Powell
County Environmental Center

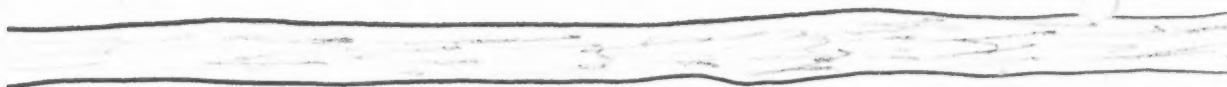
Notice the transition from
from grass to deciduous to
coniferous forest



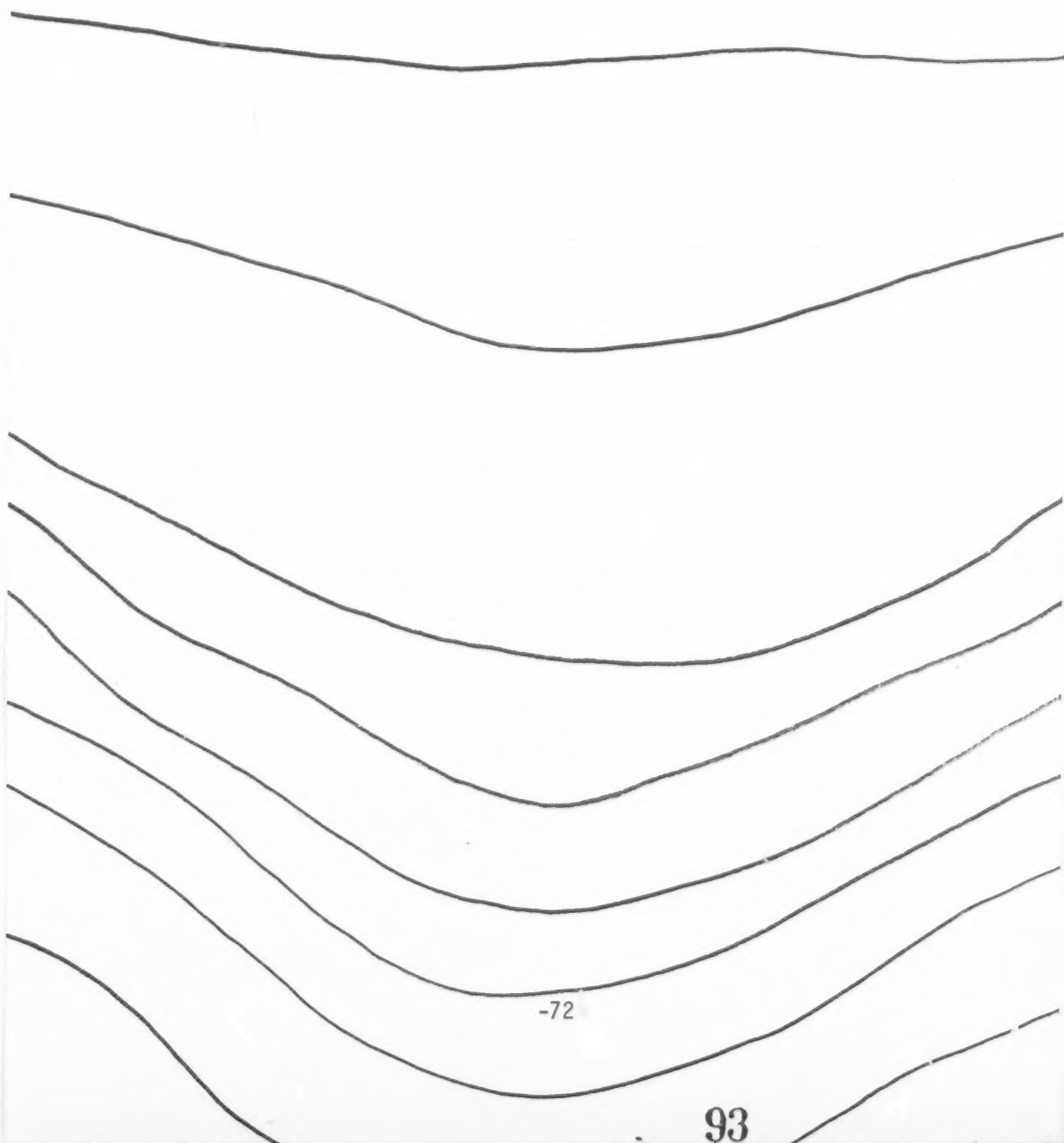
Here we are looking across
the deciduous forest into
the coniferous forest



What is the role of the mushroom in our environment?

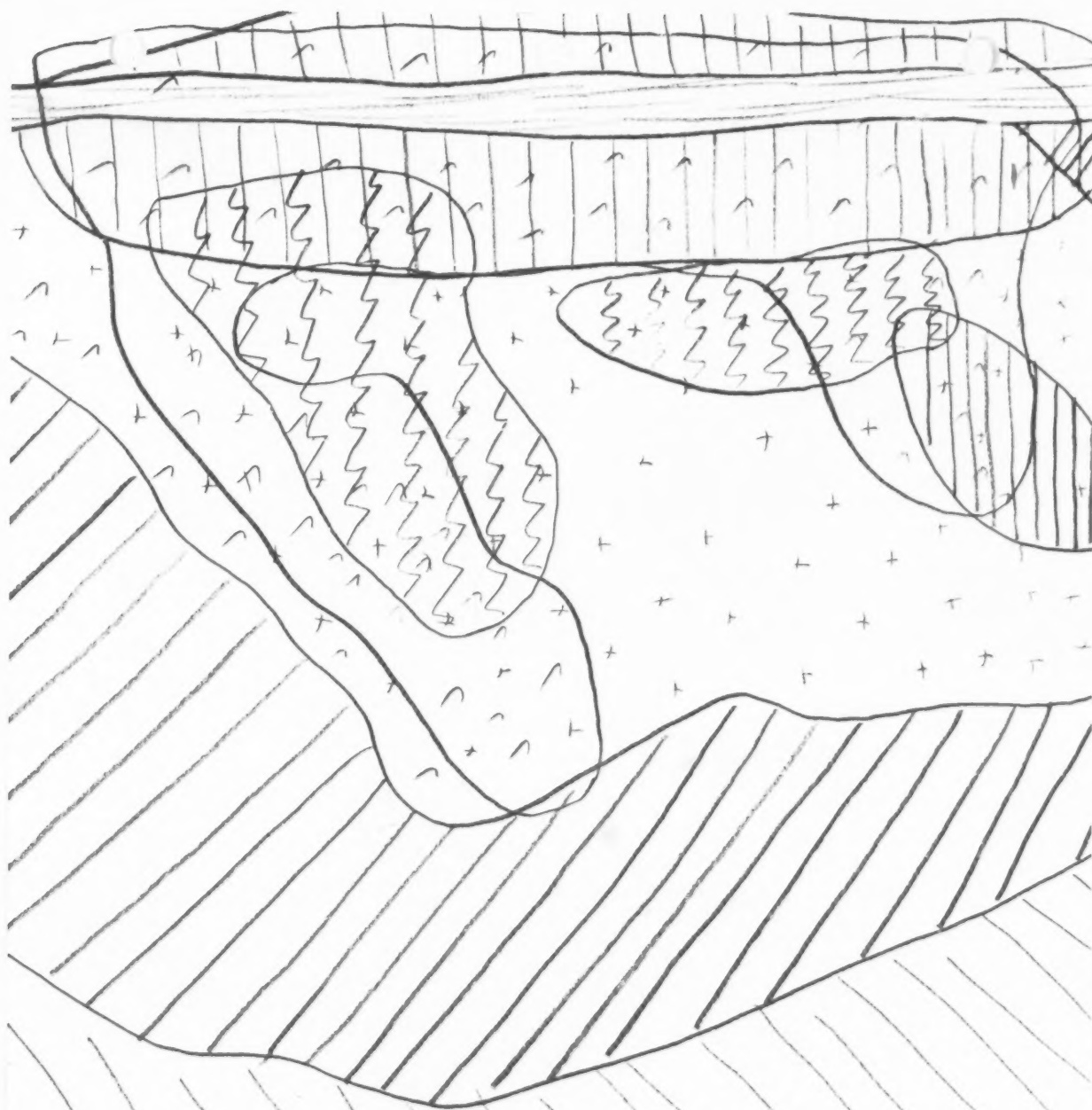


Elliston Outdoor Area Topography Map



-72

93



Elliston Plant Map

Code-
Golden Weed SSS

Rose ✓✓

Grass +++

Potentilla 

Quaking Aspen 

Lodgepole and Douglas fir 

-73-

COMMUNITY NAME: North slope and grassland
LOCATION: Elliston
ELEVATION: 5450
TERRAIN: Northwest facing sidehill and grassland
COVER: 80% cover on grassland, 30% on Hillside
WATER: None

BOTANICAL DATA:	Trees and Shurbs	Forbs	Grasses
	Quaking Aspen	Yarrow 2.3%	Smooth Brome 42.7%
	Douglas fir	Avena 3.1%	Bluebunch 3.8%
	Lodgepole pine	Brown-eyed S. .7%	Timothy 10.8%
	Juniper	Geranium 5.4%	
	Rose 7.6%	Daisy .7%	
	Kinikinnick	Cinquefoil 6.9%	
	Raspberry	Goldenweed 13.3%	

ZOOLOGICAL:	Mammals	Birds	Insects	Fish
	Deer	Robin	Mosquito	
	Gophers	Sparrow	Fly	
	Squirrel	Hawk	Gnat	
	Chipmunk	Bluebird	Spider(not insect)	
	Rabbit	Magpie	Ant	
	Fox		Beetle	
			Beetle	
			Ladybug	

GEOLOGICAL DATA: ROCK TYPE--Igneous extrusive
Main minerals-- basalt
Exposure-- Northwest
Soil origin-- volcanic outflow
Type- mollisol(colluvial), alfisol
Depth- ½" Ao, 7" A, 9" B
pH-- 5½

ECOLOGICAL DATA: Successional Observation- Many new Quaking Aspen
down the hill from stand

Proposed Climax Species-- Aspen and grass
Deer and insects

Suggested Biome Name-- Douglas fir-Smooth brome

ACTIVITY SECTION

The following activities are ones that your students can do in the outdoor areas. Be sure and look at the code for the areas and grade levels that it was written for.

ACTIVITY ONE, AGE 3-10, Area A,D,E,G,O,H Author- Albert C. Finley

Purpose: Collect relative data, and correlate to determine the territories of breeding birds in a particular ecosystem.

Collecting the data: To determine the nesting territories of breeding birds, a field map of the area to be studied is first prepared. Mark off the map of the area with coordinate lines. Make the area between lines small enough to be accurate in locating your field observations. For your field observation take a map of the area and walk through the study area marking your data on the map. Using the symbols indicated make notes of the following on the map.

a single male.

two males singing in
same spot simultaneously

a female

young birds(mark number
inside the symbol

two males fighting

Initial each symbol on the map so you can identify it with the species which it represents. (Check the bird books available in the center) A singing male is assumed to be in a territory with a mate and a nest although this may not always be true. You may also find it helpful to note such things as the shells of hatched or broken bird eggs, feeding birds, and so forth. For any other things you find to be important to note develop one symbol to use and stick with it.

When making the first field trip you will have to identify each species of bird and thereafter watch for new arrivals in the area that will have to be identified. Identify species in the field, by visual observation, by song, and by nest and egg.

Correlating data: After all field trips have been made and all data collected plot all observations of one species on individual maps. Instead of plotting the species initials or number, label the symbols with the dates of the observations.

From this many questions can be answered and many will occur to you. What is the size of breeding seasons? Do territories of different species overlap? Do the territories change in size?

ACTIVITY 2, Age 1-6, ADEGHO Author US Forest Service
Blacktop Ecology

Activities

Effects on temperature

Place thermometers at various points at comparative and varying elevations around the blacktop to determine how it effects the temperature

Do the same for wind direction and wind velocity

Wildlife: Homes of insects, who lives here, place food on blacktop and discover what it attracts.

Plantlife: Any evidence of plant life? Where is the best place to look

Make a sundail

Write a paper on the life of an animal who lives in the blacktop

ACTIVITY 3 Age 3-10 AREA ADEGHO

Author Gary D. Swant

Sampling

Objectivies

Show the students ways to measure the environment

Show the students meaningful ways to use mathematics

Find the density of specific plants

One of the most common tools used in environmental studies is that of the sample. At some time or another you will want to know the number of something as it relates to the total area or as it relates to another object. The degree of difficulty depends on what you are measuring and how accurate you want the density number to be.

Task One

The first thing that the student must determine is the size of the area. It is easiest to measure a square or rectangular area than any other type. Pick out a large part of your outdoor area (40 x 50feet) Have the students determine the AREA. The area is found by LENGTH x WIDTH. After this has been determined have the students count all of one type of organism. Preferable this should be a plant which is easy to identify. A good way to do this is to have the students all stand behind a line and move slowly across the area counting all that they find of the species.

Next have the students determine the DENSITY. Density is equal to the number divided by the area. Thus the answer would be in ___ plants per square foot (sometimes meters). Have the students repeat this 3 times and compute an average.

Why were the three answers that you obtain all different?

Why did we take an avarage as our answer?

Next ask the students to measure the number of them on the whole mountain side.(Make the area so large that to do the work would be impossible.)

continuation of activity three

Discuss with them how they might measure the hill in a reasonable manner. Sooner or later they might come up with the idea, or you can suggest the idea of a random sample. Once this is established ask the following.

What size sample would you use in a random sample? (square foot)

Have the students make out of wire a square foot. Next have them throw them 20 times recoring the number of plants that they found each time?

How would the density be found?

Compute the density.

Answer the questions

Compare the answers with the complete count method and discuss the answers?

When would you use which system?

Which is more accurate?

This is how we sampled plants, how would you sample animals?

ACTIVITY 4, Age k-12 Area ADEGOH

NATURE'S ART

Children learn faster, more, and more enthusiastically when they touch the real world rather than only vicariously as in the case with many classroom activities. This is the feeling behind this exercise.

Take your students out to the area and find an object to be drawn. Find an object that is relatively easy to draw and simple lines. Examples would be a rock outcropping, a stump, a dead tree.

Give each of the students a stiff peice of white paper. The ideal substance here is poster paper of the 110 pound variety. This is firm enough that the students can draw on it with out the aid of a desk.

Ask the students to draw the objects as accurate as possible using natural materials that they find around them.

The students are amazed at the color that can be found in the materials about them. Do not suggest to the students what they can use, but let them explore. A peice of burnt wood is a good place to start. It gives the grey-black charcoal color. Different grasses and forbs give different shades of green. Most flower petals rub their color off on paper. Let the students be creative.

Give the students about 20 minutes to do this. At the end of the time allotted ask the students to write a title for the picture on the bottom of the paper. Next have them turn the paper over and write the following.

Write 3 action words to describe the picture.

Write a short paragraph describing how this fits in with the plan of nature.

Tell what this object might looklike twenty years from now.

After the students have written down their answers have them discuss their answers with each other.

ACTIVITY 5, Grades 4--8, Area--All

FALLING LEAVES

Open lesson with two questions: 1) What happens to leaves that fall from trees? 2) Why don't they pile up in the forest?

In this exercise you will have two setups. One will be in the field and the other will be found in the classroom.

Go to the outdoor area and find an area having a lot of leaves. Mark this area off and place only the number of leaves in it that you think is practical to keep records on. Draw the marked-off area indicating all leaves.

Take leaves back to the classroom with you and also the soil from the area. Place the soil in a pan and place the leaves on top of it. Keep moist. Take a few remaining leaves and imbed between two layers of laminating plastic as a control.

Develop a recording class chart.

For as long as practical note the results of both the indoor and outdoor plots as to the leaves. Through the winter months keep records on the indoor one only.

At the end of the experiment answer the following questions: 1) What happened to the leaves? 2) Was there a difference between the two setups? 3) Is this a necessary part of nature?

ACTIVITY 6, Grades 3--8, Area--All

SEED COLLECTION

In the fall of the year most seeds are mature and await transplant from the mother plant to a new area to start a new life of their own.

Go over the life cycle of a plant with the students and then tell them that they are to go to the outdoor area and find as many types of seeds as possible and look for evidence as to how they are transported to a new site.

Have all the students do this and bring the seeds back to the classroom and have them present their findings to the class.

There will be some seeds that will have been found by all students, but do they agree as to how it is transported?

Class posters can be developed.

ACTIVITY 7, Grades--3--10, Area--All

SOILS AND WATER

The following exercises should be done after the soil investigation.

What is the relationship of soil and water?

Go to the outdoor area and using the information that the students learned in a soil investigation gather at least a gallon of all the different types of soils that they can. Identify them as to sandy, clay, loam, etc.

- Task 1: Fill a glass funnel with each of the types of soil and place over a container that will catch the water as it comes out the bottom. Have each funnel with the same amount of soil and pour into them equal amounts of water. Measure the time difference in the speed of water passing through, and the amount of water that was retained by each.
- Task 2: Take soils and weigh out a certain amount of them and weigh. Wet each to the point of saturation and weigh. Weigh daily until they return to the original weight and note the number of days.
- Task 3: Take lantern chimneys and put soil in them and set in beakers of water. Note the rate at which the water rises in the soils.

Consider the answers that you got from the three tasks above and answer the following questions:

- 1) Which soil would erode fastest?
- 2) Which soil is best for a garden?
- 3) Which is best for a reservoir for water?

ACTIVITY 8, Grades--All, Area--All

POETRY AND STORY WRITING

The idea of taking students outside to read poetry or stories is not new; but there can be some new approaches by using the outdoor areas.

- 1.) Find an area that duplicates the scene or mood of a reading and then read the selection with the students there. After the reading ask the students if they have the same type of feeling about the area as the author.
- 2.) Have the students go outside and find something they like. At an ant hill, a gopher hole, a plant, etc., have them write a story about it. You might even want the student to include a drawing or a polaroid picture.

ACTIVITY 9, Grades 2, Area ADEGOH

ECOLOGY-HABITAT

Continuation of Activity 9

- Behavioral Objectives: At the completion of this encounter, the student should be able to:
1. Describe the concept of habitat.
 2. Identify the types of habitat found around school site.
 3. Explain why and how the habitat is always changing.
 4. List natural or man-made forces that might alter habitat.
 5. Identify ways that man has managed habitat areas to help wildlife.
 6. List possible habitat improvements for certain animals on the school site.
 7. Design a habitat improvement project for a specific species.
 8. Carry out the habitat improvement project.

Activities:

1. Informal oral pretest--what do you think all animals need to live? What are the specific needs of a racoon, deer, chipmunk?
2. Orientation to the meaning of habitat. The total of all environmental factors--food, water, cover and protection--that must be present for a given animal to survive and reproduce. This might be done through class discussion, film strip, movie, etc..
3. Walk around the school site. What types of general habitats do you see? Field, wetlands, woods? What animals could live in these habitats?
4. Walk through a field community and examine it more closely.
 - a. What types of animals could live here? Rabbit? Moles? Pheasants? Field mice? what are their habitats? Why do you think so?
 - b. How do you know for sure which of these animals really live in your particular field habitat? (By seeing them, finding their homes, studying tracks and droppings, live trapping.) Examine the area for nests and tracks.
 - c. Use a live trap from the research center or have the students make one. Set it up in the field. See if any field residents are caught. If so, note the animal and release as live trapping should be used to identify the animals that reside in an area, and not for bringing the animals into the classroom.
 - d. Read to students about the life habits and needs of these field animals. In what ways do all these animals need the same things. How do they differ?
5. Examine the wetland habitat. What kinds of animals might live here? Crayfish? Red-winged blackbirds? Snakes? Toads?
 - a. Check the area for tracks and homes.
 - b. Set a live trap. Examine the contents and release.
 - c. Read about these animals. What things do they need that are the same? How are they different?

CONTINUATION OF ACTIVITY 9

6. If no woodland habitat is available on the school site or nearby lot, look at a filmstrip or film on animals of the woodland.
 - a. What types of animals might live here? Squirrels? chipmunks? woodpeckers? raccoons? snakes? How can we find out what animals actually live in a particular woods?
 - b.- Look at filmstrips and read stories about these animals. In what ways are they the same, and in what ways are they different?
7. Discuss the idea that some animals have a large habitat encompassing more than one community. Can you name some of these animals? How do they use different parts of this habitat? (One part for shelter, and another one for seeking food.)
8. Make a large mural depicting three habitats of three animals. Include one that might live in more than one community. Outline those animals that you have determined are actual residents of your particular site. Do you see any pattern between all the animals that exist on your site? (Perhaps they all adapt readily to living in close contact with man.)
9. Arrange an exhibit showing the physical evidences of the presence of these animals (tracks, imprints, homes, pictures taken of these animals) on the school site.
10. Discuss the permanency of their residence in the habitat. Will they always be there? Why not? (Habitat is always changing, either naturally or by man's alterations.)
11. Look at filmstrips or slides that show how habitat changes naturally (process of natural succession in plant growth, fire disease, insect blight, storm damage.)
12. Identify the ways man can alter the habitat (bulldozing, use of pesticides and herbicides, air water and noise pollution, logging.)
13. Draw a series of pictures that illustrate the different ways that habitat can change.
14. Identify some ways that man alters the natural succession of habitat to help animals. (Maintaining sub-climax forests for deer browse, shrub areas for rabbit and pheasant cover, burning over areas of jack pine forests to reestablish these same types of forests as a habitat for the different kinds of birds.)
15. Reexamine the animals living in each community. Can some animal's habitat be improved by men? Why would you want to do this? How would you do this? (Set up brush piles for rabbits, add berry bushes for pheasants, blue jays, plant shrubs between the field and the woodland community to create edge effect, which attracts more animals.) Will the increase of one animal species adversely affect the other animals living there?
16. Invite a game biologist to make suggestions on habitat improvement. Consider the problem that you will affect the entire ecosystem of that community by encouraging the growth of one species.
17. Outline a project for habitat improvement that will encourage the growth or protection of one species. Describe the method you will follow to carry out this project.

CONTINUATION OF ACTIVITY 9

18. Design a method to evaluate how effectively the habitat improvement is working. Do you see more of these animals in the area? What are some other ways you can tell if these animals are more abundant? Do you see any adverse effects on other members of that community?

ACTIVITY 10, Grades 1--5, Area ADEGO

INVESTIGATING LIFE OF THE FOREST FLOOR

- Behavioral Objectives: At the completion of a successful encounter, the students should be able to:
1. Draw a micro-plan of the forest floor. Show a variety of plant and animal life found there.
 2. Write a short paragraph describing what happens to twigs, leaves or trees that fall to the forest floor.
 3. Describe in writing how plants compete with each other on the forest floor for nutrients, sunlight, and water.
 4. Orally describe the variety of animal life and their relationship to plants and debris found on the forest floor.
 5. Explain the effects of the forest canopy on the forest floor.
 6. Describe in writing (number) of man's positive and negative influences on the forest floor and its living things.

- Activities:
1. Go to a forest area. Observe the forest floor. What do you find makes up the top layer? What animal life do you find there? What plant life do you find? Has man affected the forest floor? In what way?
 2. Observe the debris on the ground. What becomes of the twigs leaves or rotting leaves? What animals break down these plant tissues? How do they live? Is this harming or helping the forest?
 - a. Explain the forest waste disposal system. Decay takes place and breaks down this top layer. As a leaf or twig is broken into finer pieces, more of its surface is exposed to decay. The deeper you dig down the more difficult it will become to distinguish where decaying leaves stop and soil begins. In this area there are many tiny animals which can only be seen through microscopes. These tiny animals aid the break-down of material. This top layer is humus--the dark material that keeps soil rich. It is composed of minerals and chemicals which are released to the soil beneath. Where did the minerals come from?
 3. Observe the plant life. If you are in the forest in early spring, what will help you distinguish one plant from another? How do the plants receive the sunlight they need for growth?

CONTINUATION OF ACTIVITY 10

Where do they get their nourishment (food) and water? How do they successfully compete for their food, water, and sunlight?

- a. You can investigate the ways in which plants compete with each other; you will need some soil, seeds, and six milk cartons.
 1. Make the "pots" for this investigation from milk cartons with one side cut out. Punch some holes in the opposite side for drainage. Fill the carton with damp soil.
 2. In the first carton make small holes in the soil $\frac{1}{2}$ inch deep and 3 inches apart. Put two marigold or mustard seeds in each hole and refill the holes with soil. In each of the other cartons place the holes closer and closer together.
 3. Water each of the cartons and put them in a warm light place.
 4. Compare the plants from the different cartons. Is there a difference in heights? In which carton did the plants grow tallest? Which carton had the plants with the biggest leaves? In which carton did the heaviest plants grow? How far apart were they planted?
4. Collect a square foot of forest floor, one inch deep, put it in a plastic bag and take it into the classroom. Spread the material out on a large sheet of paper. Go through it and see how many different kinds of animals you can find. Use a magnifying glass to see microscopic animals. Estimate the total number of animals you could find in your small chunk of forest floor. Do you think you would find different numbers and kinds of animals in other parts of the forest? In other seasons? In deeper soil?
5. Where do the animals from the forest floor live? Are any of these animals responsible for the forest floor feeling spongy when you walk on it? What other purpose, other than shelter, would the holes, tunnels, and burrows made by some of these animals serve for life on the forest floor?
6. Can you explain how the debris, plant life and animal life depend on each other for survival? Discuss. Use diagrams, showing this interdependence if necessary. Filmstrips, books, movies, may be obtained from the Center that focus on this subject.
7. What part does man play in the life of the forest floor? Can he harm natural plant life? Animal life? How? Do pesticides have an influence? Can man help nature's process in any way?

ACTIVITY 11, Grades 5--8, Area-0

INVESTIGATING ECOLOGICAL RELATIONSHIPS OF ALGAE FOUND IN A SMALL POND OR LAKE

- Behavioral Objectives: At the end of the successful encounter, the student should be able to:
- 1. Identify (number) different species of algae.
 2. Construct a graph to illustrate population changes among algae both in the laboratory and in the field.
 3. Compare and contrast the numbers and kinds of algae found in different parts of the aquatic area.
 4. Determine whether the study area is relatively sterile or fertile.
 5. Describe in writing ecological succession among algae.
 6. Draw a food chain showing where algae fit in among the other animals in the pond community.
 7. Prepare a topographic map showing the relationship to depth and contour of the study area to algae numbers and variety.
 8. Identify (number) environmental problems associated with the study areas and describe how each problem affects algae.
 9. Develop a plan of action to solve one of the environmental problems associated with the study area.

Activities:

1. Using small jars, collect small samples of mud and other debris from the study area. Also, collect water from different strata, i.e., surface, middle and near bottom. Use Kemmer Bottle from the Center for this.
 - a. Label samples as to their origin.
 - b. Examine the samples with the microscopes in the lab.
 - c. With the aid of texts and manuals identify as many species as you can.
 1. How can you begin to group algae?
 2. Do numbers and varieties of algae seem to be related to different water strata.
2. Prepare graphs showing algae-population growth curves.
 - a. What is the relationship of population growth to oxygen levels?
 - b. Do algae populations increase or decrease during certain hours of the day and night?
 - c. What are some other factors which seem to limit or speed up the growth of algae cultures?
3. Identify kinds and numbers of algae within certain ecological niches of the study area.
 - a. What if any, are the relationships of algae to water turbidity?
 - b. Why are some algae attracted to certain ecological niches?
 - c. Why do you suppose some areas of the study area have little or no algae?

CONTINUATION OF ACTIVITY 11

4. Draw a chart comparing and contrasting an oligotrophic body of water with an eutrophic body of water.
 - a. Take water samples and using the Hach chemical kit, analyze to determine dissolved oxygen content.
 - b. Using the Hach kit, analyze water samples from the local area as to nutrient content.
 - c. Using the same equipment, sample the Ph of the water in the study area.
 - d. What is the color of the water in the study area?
 - e. Make a depth chart of the study area.
 - f. What is the bottom of the study area like? Is it uniform?
 - g. Using the above information, and the knowledge you have gained, decide if the study area is eutrophic or oligotrophic.
5. Observe and identify ecological succession in the lab.
 - a. Plot a graph to show the hourly or daily rate of succession of certain algae cultures.
 - b. What seems to be the determining factors of succession in the lab? Can this be applied to field conditions?
6. Illustrate how algae fit into an aquatic food chain.
 - a. Are algae consumers, producers, or reducers?
 - b. What are some factors which might disrupt algae population thereby effecting the food chain?
7. Using appropriate measuring devices, chart the depth of the study area.
 - a. Is the depth uniform or erratic?
 - b. Is the study area natural or man-made?
 - c. What is the water source for this body of water?
8. List some problems associated with the body of water studied and show how such problems relate to the algae therein.
 - a. What is the land used for surrounding the study area?
 - b. What type of soil surrounds the area, and what type of ground cover does it have?
 - c. Are there residential homes or industry in the immediate vicinity of the study area?
 - d. Can you discern any artificial drainage into the study area?
9. Prepare a list of who uses the study area (pond or lake community) and what the uses are.
 - a. Is the study area visited frequently? If so, what is it used for mostly?
 - b. If the study area is not widely used what are the reasons?
10. Determine who owns the property surrounding the study area.
 - a. Is the land private or public?
 - b. What are the uses designated by the owners?
 - c. What are the future plans of the owners in regard to maintenance or development of the study area?
 - d. Submit to the proper authorities your evidence regarding the condition of the study area.

CONTINUATION OF ACTIVITY 11

- e. Present your recommendations to them regarding preservation and improvement of the study area.
- f. List (number) your ways of acting directly toward preserving and maintaining the aquatic areas studied.

ACTIVITY 12, Grades 3-10, Area ADEH

OBSERVING AND INFERRING WITH CROSSCUTS

Secure from the Center a series of crosscuts of conifers.

Divide your students into equal numbers according to the number of crosscuts. Ask the students the following question: What are some things you notice about the crosscuts. List these observations on your data sheet, under A. (Give them about 20 minutes) At the end of this time discuss their answers.

Of all the possible things that the students noticed about the crosscuts have them list in part B the three that interested them the most (per team). Next have them fill in the possible reason for this observation on one of them. Next have them decide how they might find out what really caused this to happen.

(To the teacher) The crosscuts are a variety of things--slow growth, fast growth, heart rot, bending, wind blown, tree line, fire scar, and normal. This the students should be able to come up with a variety of ideas.

The only way that the students are going to be able to prove which ones have come up with the right answer to the observations is to go to the field and find a tree that fits their hypotheses and core drill it. (A technique film on this is available from the Center.)

Once the students have established how to prove their ideas, have them go outside and collect the necessary information and fill in task C. Once this is done have all students meet together in the class or outdoors and tell how the information that they found either supports or disproves what they felt was the answer to the crosscuts.

EQUIPMENT: Increment bores and crosscut sections. Sample form below.

TASK A (5-10 minutes) Work with your team

Write down some things you notice about the crosscuts

TASK B (10 minutes) Work with your team

Select 3 observations about the crosssections from the group list.
List possible reasons for these observations.

CONTINUATION OR ACTIVITY 12

List ways you could set up an investigation to find out more about your observations and inferences.

Observation (What you noticed)	Inferences Possible reason for this	Investigations How to find out
1.		
2.		
3.		

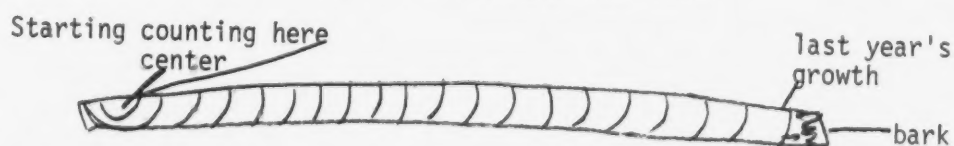
TASK C (Part 1) (15-20 minutes) Work in groups of 4-5 people.

1. Observe the tree core your group has drilled and record the following information: (See drawing of tree core to help interpret the tree core you have drilled.)

Tree #	#Dark Rings From Center to Bark Approx. age	#Dark Rings in Last Inch	Remarks about the pattern of rings

2. When your group has the above information, one person from the group should record this information on the master chart provided by the instructor.

DRAWING OF TYPICAL TREE CORE



ACTIVITY 13 Grades 3-10, Area ADEO

TREE EXAMINATION

This field exercise is designed to allow the student to investigate the age, diameter, and species of a tree. From this information the student can then figure out some simple mathematical formulas and study the difference in individual trees.

- Suggested Concepts:
1. Allow the student to learn how to age conifers.
 2. Allow the student to make simple mathematical calculations from their field data.
 3. Allow the student to identify the eight common conifers found in Powell County.
 4. Allow the student to speculate on the reasons for the individual differences in trees.

CONTINUATION OF ACTIVITY 13

This exercise is based on the fact that the student will best learn to identify the trees found here in Powell County if he has some active exercise to allow him to come in contact with the trees. This exercise allows just that. The student is first allowed to work with and use a key to the trees that are found here in the county and after working with the species of trees and viewing pictures of them the student then goes into the field and works with the trees, finds their diameter and their age. Students take samples from several areas and then discuss the reasons for the difference in trees.

EQUIPMENT: Super 8mm film on how to use increment bores
Increment Bores
DBH tapes
Tree Keys
Hand Lenses
Straws
Meter Tapes

SCHEDULE: At least 3 class periods should be allowed for the pre-work in class, a period or extended period outside, then two follow-up periods.

Introduce the students to the use of the dicotomous key by having them make several little ones after you introduce the following rules:

1. A dicotomous key is a two-part key. Each part has two steps.
2. Each step has either an identifying name or a direction to follow.

Have the students make a key to the following items: a) toothpick, b) safety pin, c) babyfood jar. Give the students plenty of time to work with the key and have success. The key could look like this when it is done, but other forms can also be correct:

- 1a. Those made of glass--babyfood jar
- 1b. Those not made of glass--go to 2.
- 2a. Those made of wood--toothpick.
- 2b. Those made of metal--safety pin.

Continue this exercise increasing the number of items used until you reach the number 8. (This is the number of conifers in Powell County.)

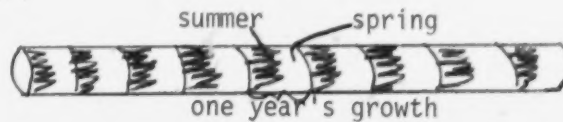
Next introduce the students to the key that was made by the center. Let them study it until they are familiar with it. When you feel that the students understand this key, bring in several branches from conifers and have the students identify them. If you use either Douglas fir or Sub-alpine fir, be sure and include cones.

Be sure and have the students use the picture key as well as the dicotomous key. Remember the idea of teaching is not to stump the student, but to provide him with success in learning.

The next part of this exercise involves a field trip. Most schools are within practical distance to drive to a conifer forest. The idea of the field trip is to allow the students to apply their knowledge about trees and to learn some field skills and techniques. The students will use increment bores, tree keys, DBH tapes and meter tapes. Before going to the field several things must be done. The most complex item to learn how to master is the increment bore. A film is included in this kit for the

CONTINUATION OF ACTIVITY 13

students to learn how to do this work. In counting the age of the tree note that there is within one year's growth both spring and summer wood and the total of the two makes up a year's growth for there is no growth in the winter.



To age a tree take the DBH tape and at breast height take the circumference of the tree. Read the DBH tape and this will give you the diameter of the tree. Drill this distance into the tree. Next, hold the center core remover in the bore hole and turn several more times while not allowing the remover to turn. Pull out the core remover and the core will come with it. Have the student place it in a plastic straw and identify it.

The students should divide into teams of three. Have each student do a 50-meter sample through the forest. To do this, two students simply hold the tape so that the third student can do a sample tree at each 5 meters length. To do this the third student walks to the first five meter mark and holds his arms out straight. The nearest tree to his hands either on the right or on the left is sampled. The species is first determined, then the diameter, and then the age. This information is then recorded on the form inclosed which is marked FIELD DATA. Stress the importance to the student of a random sample in doing scientific work. If all students run their tape lines east and west with the sun, this also aids in being random.

On the back of the form is a number of mathematical computations that can be done with the information that the students have collected.

Note--it will soon become obvious to the students that trees can have the same diameter and be different ages. Let the students discuss the reasons for this. This might even lead into another field trip to investigate the reasons. Micro-measurement equipment is available through the Center.

ACTIVITY 14, Grades 4-10, Area ADE

MISTLETOE

The purpose of this exercise is to familiarize the students with some of the details of the mistletoe disease.

BACKGROUND: The mistletoe is a parasite seed plant which is found in many forests throughout the world. It grows on deciduous as well as coniferous tree. If one passes through a region where common mistletoe grows he will see large, twiggy sphere shaped growths on many branches of the trees.

The reason for this growth form is that the mistletoe slows the growth of the tree and the tree tries to over respond to this and grows rapidly causing a whorl. In the fall of the year, the growths have a yellow-to-orange color and are quite different from the gray of the bark of the tree. The plants have no roots of its own to obtain moisture from the soil. Instead when it is very young and developing from a seed, it produces tiny outgrowths. These outgrowths pierce the bark of the young plant and it continues to grow as most plants with no nourishment from the soil.

The plant has leathery opposite leaves and small inconspicuous flowers with no petals. As the berries ripen they either pop and spread their spores or are eaten by birds and passed on and spread in this manner.

At this time have the students view the film "Mistletoe" and the slide series Clearcuts.

FIELD WORK: Because Mistletoe is generally restricted to Lodgepole pine in this area, have the students either go as a class or by themselves and view mistletoe growing on trees. Have them do increment bores on infected and non-infected trees and note any differences that might occur.

Students may want to put together a display on mistletoe.

At this time they may ask the Forest Service to come and talk to them about mistletoe control.

ACTIVITY 15, Grades 6-8, Area--All

GENETIC DIFFERENCES IN SEED CONES IN EVERGREENS

Have students go to the field and collect cones of Lodgepole and Douglas fir. Be sure that the cones are mature, and that the seeds are still within the cones. This is best done by taking the seed cones off the trees.

Using a thermostatically controlled hot plate raise the temperature of the plate in 10 degree intervals as the experiment develops. If this

CONTINUATION OF ACTIVITY 15

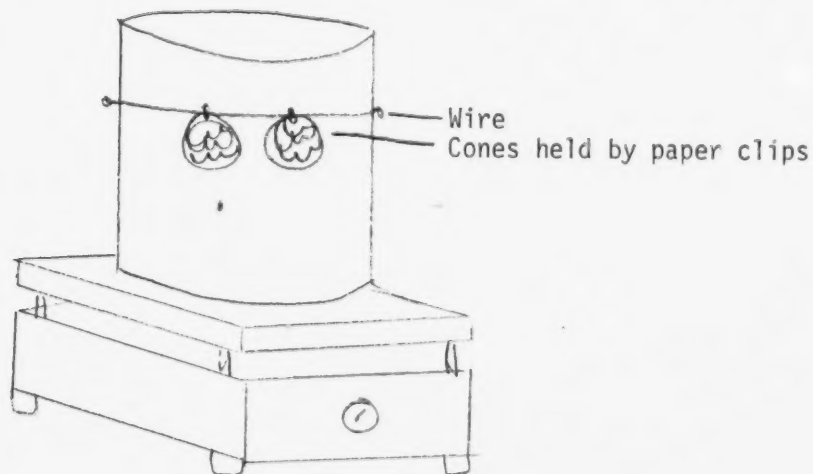
is not possible suspend a thermometer from a wire in the apparatus as shown below.

Construct the following using a gallon can. Suspend your two cones from the wire in the can. And note the results as the temperature increases and then decreases.

PROCEDURE: Once the apparatus is set, raise the temperature in ten degree intervals and hold for five minutes. Continue this up to a temperature of 200 degrees. Then shut the temperature off and continue to watch.

The Lodgepole cone should open after cooling and Douglas fir cone should burn. After the cone opens the seeds will fall out.

- QUESTIONS: 1. What is the significance of this for the survival of the Lodgepole?
2. What would come in first in a forest after a fire?
3. What is succession?



Activity 16, Grade 1-8, Age All

ANIMAL BEHAVIOR

Most animals that science works with are either too large, small, hard to work with or too small for elementary handling.

This exercise is designed to allow the small students a chance to observe animals as a group and discuss what they see.

The role of observation can teach children patience and give them an opportunity to think about what they see.

Start by using the Mercury ameabe and having them observe it.

Use dilute nitric acid in a petri (flat bottomed) and set in on an overhead projector. Add without the students seeing a drop of mercury. It will react with the acid and move around in all directions and appear alive. Start having the students make observations. Next add a smaller drop of Hg. The larger one will appear to chase it and devour it. Next add a drop of pollution (Potassium chromate) and the mercury will either back away or go through it very quickly.

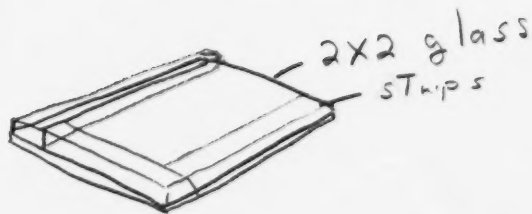
After all of this then react with the students about it. Eventually tell them what it is and caution them as to what they see and how they interpret it.

Next have students make viewing chambers for small aquatic organisms.

Obtain plexi-glass and cut into two 2x2 in. square. Also cut $\frac{1}{2}$ x2 in. peices. Lay one 2in. square on table and glue (water proof glue) the $\frac{1}{2}$ inch strips to it as in the diagram and then glue the top square to it. You now have slide projector viewing chamber for living organisms.

Have the students go to the field and collect living aquatic things and bring to class to study. This can also be done on the overhead using a petri dish only.

In both cases avoid prolonged heating of the organisms. Some have smoked the glass to deep temperatures down.



ACTIVITY 17, Grades--1--4, Area--A11

A WINTER STUDY OF SNOW

Task one Take some powdered tempera paint and create something in the snow.
Check several days later.
What has happened?
Is there a difference between different paints?

Task two Cause a snow drift on your area.
Can you change the direction of the drift?
Can snow drifts effect the paints in an area? How?

Task three How many cups of snow does it take to make a cup of H₂O?

ACTIVITY 18, Grades 1-10, Area A11

OUTDOOR WATER TASK

Make a mini-oil slick. FIX IT!

Put the same amount of water in different types containers. Place both containers in sunlight.
Graph the results. Why the difference?

ACTIVITY 19, Grades 1-6, Area A11

WHAT DO INSECTS DO TO PLANTS

Go to the outdoor area and find plants and their stems with aphids or cists on them. (A good plant to look at is the rose.)

Have the students observe these plants in tact and answer the following questions:

1. Do plants get sick?
2. How do you know they get sick?
3. What causes them to become sick?
4. Can things be done to stop this?
5. Should things be done to stop this?
6. Can insects be benifioial?

ACTIVITY 20, Grades 4-8, Area AGEOD

WHAT KINDS OF PLANTS GROW ON THE BARK OF TREES

Go to the outdoor areas and observe trees. Have the students collect things off the bark that they think are plants and are not part of the bark. Take this back to the classroom and observe it any way that the students want to. (Possibilities- stereoscope, microscope, hand lens)

Answer the following questions:

1. *How are they able to grow on the trees?*
2. *Does it harm the tree?*
3. *Are there more than one type of these plants?*
4. *Can you find a way to identify them?*

ACTIVITY 21, Grades 6-10, Area A11

THE MICRO-HABITAT

The micro habitat is described as a small area that is found within a large area and has different physical and biotic features. Thousands of these can be found anywhere, but there are certain places where you might have better luck finding them. I will list several of these here and tell you how you can work with these.

two sides of a rock	two different slopes of ground
under a log	a level place and a hole in it
in front of and behind a tree	a level place and a rise
in front of and under a tree	a dry spot and along a creek

The first thing that should be done is to find out how the plant and animal life of the two places vary, and record this for class use.

The difference in plants and animals is directly related to the amount of solar energy that the area receives from the sun and the amount of available moisture. Thus you will want the students to measure the temperature difference of the two areas and the amount of available moisture.

The available equipment is available for this from the center.

Hydrothermographs- this is a machine which measures the temperature and the relative humidity on a 7 day period.

Soil thermometers- reads the temperature of soil.

Sling psychrometers-measures air humidity

Thermometers and soil moisture meters.

These can be interesting and fascinating studies.

ACTIVITY 22, Grades-all, Area- non, but all areas have streams.

WATER POLLUTION

WHAT TO MEASURE AND HOW TO MEASURE, AND WHAT DOES IT MEAN

The degree that you go into this and the amount of sophistication that the student can handle depends on his age, but basically you still answer the same question.

As the stream passed point X (city, ranch, ect) was there an increase in the amount of foreign matter in the stream (pollution)?

Available in the center is a host of materials to measure water. Following is a number of factors that should be measured and how they can be measured. If a high level study is desired check out the pamphlet "Investigation of a Water Pollution Problem".

Heavy Ions - Mg, Cu, Fe, ect La Motte Kits, directions within

Oxygen, CO₂ La Motte

Turbidity - La Motte

Light penetration- A secchi disk is lowered in water to the level that the black part of the disk can not be distinguished from the white and this is the level of light penetration

Temperature - Stream thermometers

Organisms- aquatic keys

The actual measurement of the physical and biotic differences in a stream is not difficult but the meaning of these readings is. At this point I would suggest that you contact the center and we will come out and talk to the students about this.

*

ACTIVITY 23, Grades 5-10, Area all

RANGEMANAGEMENT

Available through the center in our pamphlet series is a book on Range Management. Also available are slides of all the grasses found here in the valley. This material is adoptable to almost any age depending on how it is done. Check out this material and if assistance is needed call us at the center.

ACTIVITY 24, Grades 1-4, Area ADGEO

DEATH OF A TREE

In most of the outdoor areas you will find one or more dead or dying trees. Have your students observe and speculate as to why and see if they can come up with some answers.

This is a very open ended activity but it does give the student a chance to think and test his thinking.



What could it be?

age,
disease,
lighting,
water

How would you find out?

ACTIVITY 25, Grades 1-4, Area A11

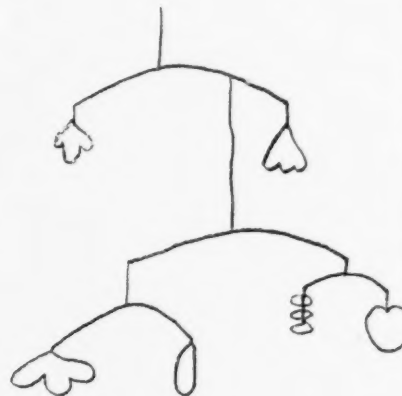
BUILDING A MOBIL

The idea behind this activity is to let the students investigate something that they like in their outdoor area, or something they don't like and make a meaningful display of it. This activity can also be used to teach the children how to balance objects.

Make a mobil of the different trees found in your area

Make a mobil of the pollution in your area

Make a mobil of leaves



ACTIVITY 26, Grades 4-8, Area DEGOA

SOIL FORMATION

Establish with you students that soil is the product of the weathering of the solid rock or parent material of the earth.

Demonstrate two ways that soil is formed.

Find a rock with a small crack in it and pour water in it and freeze it. Do this several times and note the effect on the rock. If the rock does not crack completely in two it should at least open wider. Explain to the students that in nature plants grow in these cracks and even further the effect.

Take a pine board and place on it some sand and rub it back and forth with a large piece of ice. This demonstrates the effect of a glacier on the land (board) and the depositing effect of them (by the sand that became trapped in the ice).

Next have the students go to their outdoor areas and have them find evidence of the formation of soils. After they have had enough time to do this have them compile this information on the board and discuss.

Have the students map the depth of soil on a hill from the top to the bottom and have them explain the results that they obtain.

A field trip to a glacier can be arranged by calling the center.

ACTIVITY 27, Grades 1-8, Area-all

INVESTIGATING A BIRD NEST

If exercise one is done this exercise might also be considered. In watching birds and their territories or in working in the outdoor areas one will frequently run on to bird nest. If the children are interested they can set up a watch station from a distance using glasses and note the activity of the female, male and the chicks as they develop.

Stress to the students that little is known about many of the birds and their life histories are incomplete. Thus, they may find out things that are not known so accurate records of their work should be kept. This can later be written up for English.

We have made a film on the sparrow hawk and its activity in raising its young that you might want the students to view before they begin this kind of work.

ACTIVITY 28, Grades 6-8, Area all

A COMPLETE COMMUNITY STUDY

Once in a while a complete study of a community or a comparison of two communities is wanted.

The following is a form that can be used if this is desired. The students should be broken into teams of 4.

Team one- soil This team is responsible for the type of soil, texture, depth, ph, temperature. Caution you students to cover the hole up once they are done.
Equipment- Sudsbury soil kit, soil shovel, soil increment bore, soil thermometer, calcium bottle (dilute HCL, box to place soil in.

Team two- Animals This team is responsible to find out all the animals, large that you might find in the area. This would include tracks, scat, sightings of birds and a trap line for small rodents.
Equipment -binoculars, traps (snap, and live)

Team three- trees This team is responsible for setting out a transect of say a line fifty feet long and recording the age, diameter, relative density, and species of all trees along that line.
Equipment- Measuring tape, increment bore, tree keys, DBH tape.

Shrub team - Their responsibility is nearly the same as that of the tree team only this is usually done in a 10 meter square.

Surface team- This team is to use a one meter plot and analyze the grasses and forbs as to the species and relative percentage.

Soil Organisms- This team is to take the top layer of the soil and place in a funnel with a light above it, supported by a ring stand. The organisms will be driven down through the soil by the heat of the light and will drop out of the bottom of the funnel. At the bottom of the funnel should be a container of alcohol to collect them in.

Non-living factors- This team should gather all the information that they can on the physical factors of the site. Altitude, slope, direction of slope, wind, temperature ect.

After all teams have completed the work as a class this should be summarized on a community sheet form available at the center, all equipment is available at the center as well.

For best success let the students work out the details as to what to do and how to do it.

ACTIVITY 29., Grades 6-8, Area OEAD

NORTH VS SOUTH

Using the information on exercise 28 one can study a north vs south study where all environmental factors except for the amount of solar radiation received are the same.

Of course this causes all other factors to be different. This is an important fact to get across to the student that the amount of solar radiation is the most important single physical factor in our world.

Example- If the sun shown directly on the North pole there would certainly not be any artic.

ACTIVITY 30, Grades 6-8., Area H

SAGE BRUSH CONTROL

Sage brush makes up a great part of the community of plants of the Northern part of the county. There are many theories as to what caused it and whether it is climax or not.

This much is known. Grass can be burned off with little damage to the plant. The plants grow from the ground up. Sage brush on the other hand grows from the tips and burning it reduces the size of the plants ability to undergo photosynthesis and retards the plant many years. It is also known that the complete life cycle to the time of a seed being produce is around 3 years whereas the complete life cycle in a grass is one summer.

Putting this together with other information that you can gather is it possible to develop a plan for the control of sagebrush?

What is the environmental consequence of such a plan?

Should you test your ideas on a small part of your area?

ACTIVITY 31, Grades 3-8. Area AEDO

SUCCESSION

One of the best ways to study succession in a short period of time is to study the rotting of a log. You can usually find several trees in different stages of rot and the complete cycle can be observed. I have listed here the major stages of rot and you should let the students go to the field and observe trees marked for observation. Then meet with the students and discuss their observations and the importance of this cycle.

STAGE ONE Standing dead tree

Is there bark on the tree? Is the bark easily removed? Is the wood hard, dry? Are there any invertebrates or vertebrates in the wood? Under the bark?

CONTINUATION OF ACTIVITY 31

STAGE TWO Newly Fallen Tree

Is there any bark? Is the wood firm or soft? Is the wood wet or dry?
Are there any animals? What kind?

STAGE THREE Log rotten inside - firm Outside
Lift off the outer shell- note animal life

STAGE FOUR Completely rotten log
Is the wood moist. Are there any plants? Animals?

ACTIVITY 32 , Grades 6-8 , Area All

ANIMAL STUFFING

The stuffing of small animals can be a great deal of fun for students. The following is the general rules for stuffing animals and you will find in the center a film entitled "Stuffing Small Rodents."

1. Make incision in skin of the abdomen, either laterally from knee to knee or from back of sternum to anus.
2. Remove skin along incision, until knee can be pushed up. Cut off hind leg at knee joint.
3. Remove flesh from leg bones and pull back into place.
4. Skin around back until all is free except tail. Remove tail vertebrae by holding vertebrae with forceps and holding fingers in front of tail skin to prevent it from turning inside out.
5. Slip skin over body to forelimbs. Cut forelimbs at knee.
6. Skin over back of head until skin begins to pull back at ears. Clip close to skull.
7. Cut tissue connecting skin to skull around eyes. Then skin mouth, carefully cutting skin away from skull until free. Cut off skull.
8. Remove all excess flesh and fat, rubbing skin freely with borax.
9. Roll a piece of cotton to approximately the size of the body. Insert into body and wrap legs.
10. Wrap a thin layer of cotton around a wire about an inch longer than the tail and insert it into tail.
11. Pin it out to dry and board.
12. Label.

Small rodents can be found anywhere in the county by using snaptraps available at the center and a mixture of peanut butter and oatmeal for bait. Be sure and flag your traps so that you can find them again.

ACTIVITY 33, Grades 1-5, Area A11

TRY A PLANT OBSERVATIONAL PROJECT

Do the children with whom you work realize how much things around them change and develop from day to day? Do they look but rarely see? Do they need more experiences requiring them to observe closely, examine and describe what they see? If so, try an Observational Project with a plant as the focus.

Have each child select a plant (or preferably a part of a plant such as a bud) to examine and observe for a five-minute period each day. Have him report in writing everything that happens to his plant or changes that occur. Have him measure any growth. Continue the activity for several weeks.

The projects may be either on the school or camp site or at the children's homes. They should be advised to select items that might show appreciable change, and be cautioned not to "bite off" too much. Before beginning, memories should be refreshed about the use of scientific controls and the design of record keeping systems. Greatest success results when items like the following are selected:

A rose bud as it expands, blossoms and withers.

A hickory bud as it unfolds in the spring.

A corn, pumpkin or other rapidly growing plant or vine.

Events on a window, or a particular square foot on the lawn.

The plant or animal communities on a rotting log or stump.

Expect some difficulty for days until the children begin to see and perceive. As they become more familiar with their project, observational powers will improve and they will see much more to report. Every day several of them will have "exciting news" or discoveries to relate to the rest of the group: "My pumpkin plant grew three inches yesterday." "My bud is opening." "I didn't know there were so many ants."

Eventually pupils will become interested in projects other than their own and will want to be kept informed. Many will want to know explanations for what they see. Questions will arise that can be answered by returning for additional observations or consulting references. Pupil observations and reporting will then take on a new and added dimension--to convey accurately to others events and changes in the projects as they occur.

ACTIVITY 34, Area all , Grade --all

TIPS FOR IMPROVING CREATIVE WRITING

The out-of-doors provides opportunities for creative writing as well as note taking and other forms of language arts experiences. Good planning is vital if the experiences are to be satisfactory. If children are to write, they should have experiences to make them aware of topics for their writing. Below are some "lead up" experiences that may help children to develop positive interests and attitudes:

1. Sensory exploration of natural phenomena:

a. Have the students close their eyes; touch bark, leaves, feather, rock, etc.; and describe what the object feels like. Let several persons use descriptive terms to tell what the object feels like. Use other senses in similar activities.

b. Have them play games in which attempts are made to describe objects using similes, metaphors or comparisons.

c. Have the students make up short rhyming descriptions or list as many terms as possible that describe a phenomena.

2. Use the environment to set a mood. Look out over a vast expanse; look up through the trees to see the patterns of leaves; examine a hole in the ground or in a tree.

a. Ask for short verbal reactions to common and uncommon objects and surroundings.

b. Select poetry and stories to read appropriate for the environment in which you are working (read poetry about trees and forests when in a wooded area).

c. Concentrate on a series of short phrases before getting into stories--Haiku poetry is a good introduction to writing for children in the intermediate grades as is writing lyrics to songs about their experiences (to tunes such as "Hey Lolly, Lolly").

d. Brief accurate recording of data describing phenomena also has carry-over value into creative writing. Have students focus on smaller less obvious objects, or search for unusual phenomena.

ACTIVITY 35, Grades 1-5. Area - all

A NATURE PICTURE

Supplies: Backing material such as cardboard or masonite, string, glue, poster paint; and natural materials such as dried grasses, corn shucks and kernels, sand and pebbles, twigs, seeds, etc.

Tools: Knife

- Directions:
1. Cut a piece of cardboard (or the material you are using for backing) to the desired "picture" size.
 2. Paint the background a solid color or spatter paint the background.
 3. Place "natural materials" on the dry painted background to form a picture or perhaps an interesting arrangement. When the arrangement is satisfactory, glue them to the cardboard.
 4. Cut dry branches several inches longer than the length of each side of the cardboard. Lash them together to form a frame for the picture.
 5. Lash, tack or glue the cardboard to the frame.
 6. Tie the ends of a piece of string to two corners of the frame so it may be hung on the wall.

- Variations:
1. Paint clouds, sky and lakes on the backing and then fill in trees, buildings, paths and rocks by gluing dried natural materials on this painted background.
 2. A 3-dimensional type of picture can be made much the same way as in (1) above by using a cardboard box.

ACTIVITY 36, Grades 1-8. Area all

AWARENESS OF THE ENVIRONMENT

Discovering the environment can be an exciting venture. Individuals do not become aware of objects found in their immediate environment merely because they have sense organs. Many persons look but do not see. They become aware of the environment to the degree they are afforded opportunities for careful observation.

The following activities may help to "sharpen the children's senses":

1. Discover objects relating to texture which can be described as slick, hard, rough, soft, slimy, velvety, coarse, knobbed, ribbed, furry, hairy, waxy, etc.
2. Discover objects relating to shape which can be described as small, large, oval, round, oblong, lobed, ridged, smooth-edged, rough-edged, triangular, pointed, curved, billowy, horizontal, expansion, contraction, etc.
3. Discover objects relating to density which can be described as spongy, solid- thick, lumpy, hollow, compact, porous, non-porous, etc.
4. Discover objects relating to temperature which can be described as hot, cold, damp, clammy, moist, dry, wet, cool, lukewarm, etc.
5. Discover objects relating to size which can be described as narrow, large, small, tall, short, thick, heavy, bulky, miniature, etc.
6. Look for evidence of life "above and around water" including insects, turtles, algae and other plants, worms, frogs, etc.
7. Observe the differences in the "bark of trees." Some may be shaggy, some will look like potato chips, some will look like the shapes and colors found on the backs of certain snakes, some will have warty-like projections, some will have deep ridges, etc.
8. Look for "domestic" and "wildflowers." Examine them carefully for the number, color, size and shape of the petals.
9. Lay out a "square foot of ground" using a piece of string. Categorize the various forms of plant and animal life found in the square foot. Also classify according to "kind" the other types of organic materials found in this square foot.

ACTIVITY 37, Kindergarten, Code ADEGOH

INVESTIGATING AIR POLLUTION

"An Environmental Encounter for a Kindergarten Class."

BEHAVIORAL OBJECTIVES:

At the completion of this encounter, the student should be able to:

1. Identify air as a physical substance.
2. Demonstrate that air contains many impurities.
3. Demonstrate its presence by its effects.
4. Identify through senses (number) uses of air.
5. Identify through ones senses (number) pollutants in the air.
6. List (number) air pollution problems.

ACTIVITIES:

1. General class discussion concerning the three basic components of the environment: When you go swimming what do you swim in? What do you splash on one another? What do you plant seeds in? What do you put in a sandbox besides toys? What makes your kites fly?
2. Can you smell, see, feel air? How do we know it is around us? Look outside and see if you can see evidence of the presence of air. Are leaves moving? Are the trees swaying back and forth? Is dust blowing around the playgrounds?
3. Find a piece of furniture or some article in the room that is dusty. Where did the dust come from? Put on the movie projector-turn out the lights - what do you see in the ray of light? How many of you have ever had something in your eye? How did it get there? How many of you have ever seen dust on plant leaves? Where did it come from?
4. Take students outside and collect leaves from different areas and show by comparison of leaves the degree of dust that had settled on each leaf. Collect some leaves from inside a forest or sheltered area from a field or hedgerow from along side a road. Which leaves are dirtier? Why? Would leaves from trees in a city be dirty? Does this dust hurt the leaf? How?

Continuation of Activity 37.

5. Try using ones senses to identify air and its impurities. How many senses will help you determine healthy or unhealthy air? Can you see dirty air? Can you smell dirty air? Can air be dirty even if you can't detect it?
6. A game could be played where a student is blind folded and one passes under his nose various pleasant and unpleasant smells--emphasize or point out that through our senses we can detect the good and bad part of many things. Also through our senses we can detect many things in air. Have you ever smelled a rotten egg? Can you smell a barnyard? Can you smell popcorn? Can you hear water running? Can you hear a dog bark? Do you hear sirens sometimes at night? Can you hear a city? Traffic? Is it loud? Is there too much noise? Could this mean air in some places has too much noise? Is it as noisy in the country? Could air then be filled with more noise in one area than another? Would noise like dust be in air?
7. Could there be a way to remedy some of these air problems that have been identified such as dust? noise? What are they? Do we have such problems in school? Should we talk to the principal about them?

Within the center there is a gas analyzer for air pollution studies that can be demonstrated to your students by the center.

ACTIVITY 38, Grades 3-8, Area A11

STUDIES ON ADAPTATION

The adaptive ability of any species is a critical factor in its ability to survive. Disruption of habitats directly affect food and shelter for living things, leading to changes in their very forms of life. Major changes often result in severe depletion or extinction of some species, while others have adapted and survived.

That living things have adapted to a variety of habitat types should be evident. The breathing apparatus of aquatic forms of life is often able to remove oxygen from the water, whereas many land animals can obtain oxygen only from the air. Many amphibians and insects move from habitat to habitat in the course of a single life cycle.

Predators can usually be distinguished by the set of their eyes and the type of their mouth and teeth. Their eyes are forward enabling them to focus on objects in front of them, whereas the teeth and mouth are designed for grasping and tearing. Birds with comparatively slender beaks are generally predators who eat insects, frogs, fish, etc. The meat-eating birds have sharp talons useful in grasping and a solid

Continuation of Activity 38.

hooked beak that facilitates tearing. The size, shape and location of the mouth of a fish tells you what it eats. Bottom feeders usually have rounded mouths located in the lower part of the skull, facing down, with eye location facilitating downward vision. "Feelers" resembling whiskers may be found on some fish such as carp and catfish. Insect eaters generally have small mouths whereas fish that eat other fish have larger mouths.

Moles live underground, "swimming" through the soil with special large, flat feet for digging. As with worms, moles have no functional eyes.

Ask questions such as these when examining the footprints of animals: Can it climb? Is it a fast runner? Can it grasp and tear? Was it walking or running or loping? Is it a nimble, graceful animal or is it awkward? Is it a good swimmer?

Protective coloration is vitally important to the survival of some animals. The female of most bird species is dull and drab--resulting in a type of protection while on the nest. Deer, rabbits and mice are extremely difficult to see when standing still in their natural habitat. Some forms of animals that are defenseless resemble others that are well armed or distasteful.

Some species can range through a wide variety of habitats, hence are found in many parts of the world. Among such animals are bears, rabbits, foxes, crows, gulls and houseflies.

A SQUARE FOOT FIELD TRIP

Directions: The students may work individually or in pairs. They will "explore and tally" those items which can be found in one square foot of ground.

Have the students categorize or classify all items found in the square foot, regardless of whether they are man-made or natural. Names or descriptions may be used.

Have them look specifically for the following types of "evidence" and record their findings:

1. Name the materials or objects found in your square foot and, if possible, tally the frequency with which they occur.
2. Is there evidence that some materials have undergone change? Describe some of the changes.
3. Is there evidence of the presence of "man" in the area? Explain the kind of evidence that would substantiate your conclusion.
4. Which objects or phenomena lend themselves to further investigation?

ACTIVITY 39, Grades 1-8, Area DGHOAE

*MICRO-CLIMATES:
A LESSON ON THE EFFECT OF WEATHER*

This lesson is designed to be part of a weather unit. Reports and forecasts may be obtained by students at their weather station, or can be obtained from the news media. Does the information in these reports imply that all points in the area have identical conditions? Are some places warmer or colder than others?

A micro-climate study focusing on temperature may demonstrate the great differences existing in relatively small areas (such as an acre or even within a 10-foot radius). On one school site, children obtained thermometer readings ranging from 60° to 124° F. at the time the air temperature was 88° F.

Areas and Time in Which to Obtain Readings:

Look for different surface materials and textures or open, exposed areas and sheltered areas and measure the temperature of each. Look for holes in trees, in the ground, in pipes, etc. Determine the temperature at the ground surface above grass, blacktop, gravel, concrete, wood, etc. Check the temperatures in the shade, and compare with those in the sun, on a south-facing slope, on a north-facing slope or on the north and south sides of a building. Check the temperature at the base of a tree, in the lower branches and at the tip of the outer branches. Determine the temperature on top of snow and compare with that at various depths.

Compare the readings taken at one time in the day with those taken at another time--say 9:00 a.m., 12:00noon and 3:00 p.m.

Determine the effect of general weather conditions and season on the temperature ranges. Are they as great on cloudy days as on sunny days?

Significance of the Temperature Ranges and Variations:

The information collected about temperature variations can be used to bring about some appreciation of the effects of weather and temperature on flora and fauna. Study the forms of life found in the various areas. Are they the same? Are the plants found in open sunny areas of the same species as those growing in the shade? Under what conditions is the greatest variety found? Where do you find the greatest quantity of plants? How does temperature affect animal activity? Where do different animals go during cold days? Where can they be found on hot days?

ACTIVITY 40, Grades 3-8, Area A11

INSECT SIGNS

Insect signs are often far more apparent than their makers, even in warm weather. Some signs are damaged or diseased plants, secretions or animals usually found with a given insect (for instance, some ants are found with aphids). Insect homes such as galls, leafminer tunnels, leaf-roller cases, cocoons, mud nests and tunnels in wood and earth are also clues to the presence of insects.

Galls. Galls are abnormal swellings or growths found on almost any part of a plant. They are distinctive and specific, one organism causing one type of gall. Galls may be caused by bacteria, viruses, mites, diptera (flies) and hymenoptera (bees). The mechanism causing them is relatively obscure, but apparently rapid uncontrolled cell division occurs in the plant tissue in response to foreign material within it. In the case of insect galls, the female insect inserts one or more eggs into the plant tissue.

Galls may be collected and dried after placement in a killing jar. However, it is interesting to try to rear the insects. The entire plant can be potted and brought indoors, or the study can be conducted outdoors. In any event, the simplest way to collect the adult insect is to construct a fine net cage around the gall until it emerges. A word of caution, however, for the insect coming out of the gall may not be the one causing it. Gall insects have parasites that lay eggs inside the gall and their young feed on the developing gall insect. Other parasites may attack this parasite, so when you attempt to rear gall insects, you are working with surprise packages!

Leafminers. Leafminers are insects that develop within a leaf. An egg is inserted between the upper and lower layers of a leaf. When it hatches, the young insect eats the spongy tissues. While some produce only irregular blotches, others tunnel through the leaf, eating as they go. These tunnelers leave irregular twisting paths that gradually widen as the insect grows. A careful observer can learn a great deal about the developing insect for the living wormlike insect can often be seen when light is passed through the leaf. These insects can be reared in the same manner as gall insects but since some pupate in the soil the entire plant may need to be caged. Leaf mines are made by larval sawflies and other hymenoptera, beetles, moths and diptera. There are about 500 species of miners in the United States each having a characteristic "mine" in a particular plant.

Leaf-rollers. Leaf-rollers are insects or other arthropods that roll leaves into "homes". Some use a cluster of leaves or individual leaves, but most cut portions of a leaf and roll them. Once recognized they are far more common than one might suspect. Most leaf-rollers are moths or butterflies and most use only one kind of plant.

Continuation of Activity 40.

Paper nests. The paper nest of the bald-faced hornet (*Vespula maculata*) is quite distinctive. These insects chew wood into a gray paper-like material and construct a nest often larger than a football, somewhat globular, and usually attached to a tree or bush. The wasp itself is large, black and light yellow, and the front of the head is light yellow (bald-faced). Caution: This insect has one of the most potent stings in the insect world.

If the nest is occupied stay away and do not annoy these insects for they are easily upset and will sting repeatedly. The fertile female winters in a chamber in a rotting log. If you find one in cold weather you may be able to examine her while cold, but do not let her become warm or you are likely to regret it.

Other wasps make paper nests but these are generally tan in color and smaller and less elaborate than those of the bald-faced hornet.

Mud nests. Mud nests are made by some wasps. The nest of the "organ-pipe wasp" can be found on buildings or rock outcroppings. These nests are vertical tubes up to about 7 inches long placed alongside of each other. The adult wasps use these tubes as "nurseries" rather than homes. The tubes are chambered, each compartment containing an egg with enough paralyzed insects to provide food for the developing larva.

Potter wasps form small jug or vase-shaped mud nests on tree branches. Each "pot" contains an egg with food.

Ground nests. Yellow-jackets, bumble bees and some other hymenoptera dig burrows into the ground. Yellow-jacket nests, for instance, contain many insects.

Most people are familiar with ant nests. Many ants live in the ground, but carpenter ants tunnel extensively into dead or diseased wood. The nests of carpenter ants are not easily confused with those of termites, for in general, termites leave no apparent outward signs except for a paper-thin tunnels of mud are often constructed for long distances between nest and soil. Termites work very fast and their nests must somehow remain in contact with the soil, hence, pencil-thick tunnels of mud are often constructed for long distances between nest and soil. Termites are mostly southern in distribution but they are slowly extending their range.

Bark Tunnels. Often when bark is stripped from logs the tunnels made by bark beetles between bark and wood become apparent. The most fascinating of these consists of a long, usually vertical channel in which the female lays her eggs. Radiating out from it are twisty channels gradually increasing in width that were made by the developing larva. Large scale infestations of these beetles can girdle and kill a tree.

ACTIVITY 41, Grades 5-8, Area A11

INSECTS FOR WINTER STUDY

Insects are cold-blooded and least active in cold weather, hence finding specimens can be difficult in the winter. Since they are present at all times, of course, the problem is one of locating or in recognizing them as insects.

Each species seems to have a stage in its life cycle that is better fitted to resist cold weather. Unfortunately for the winter entomologist most insects winter as eggs or as difficult-to-find larval or pupal stages.

Adult insects of many sorts hibernate under logs and rocks, in weed clumps, grass tufts, crevices, and among fallen litter. In the coldest weather, it is possible to find fairly active insects among the downy leaves of mullen plants.

One way to obtain insects almost any time of the year is to place a mass of dry leaves and forest floor litter into a separator of some sort. One of these is a modified Berlese (Burlaz'y) funnel. To construct this device use a funnel with a screen of about $\frac{1}{8}$ " mesh part way down to hold the litter. Next place a light (hopefully with an inverted funnel-shaped reflector) above it. As the litter dries from the heat of the lamp, insects will work their way down the spout tending to avoid the light and heat from the bulb. A bottle of preservative or an empty jar should be under the funnel.

Soil insects. If a section of hard-frozen earth is taken indoors to warm a bit, a number of insects may emerge. Often soil from areas covered by water in the spring contains large numbers of mosquito eggs. They can be hatch by placing the soil in a dish of water for a day or two. Other forms of life may appear when this is done so expect to be surprised.

Fallen logs harbor many sorts of animals in winter and insects can be found here in all stages. Some will be between the wood and the bark while others will be in the wood itself (beetles, ants, wasps and bees may be found here). Examining them outdoors is an excellent way to study many insects with powerful venom in comparative safety as they are quite sluggish when cold. Often the ants, bees and wasps found in these places are fertilized queens capable of producing new colonies.

Rock cracks harbor many insects, especially beetles and Hemiptera (true bugs) hibernating for the winter. On bright and sunny winter days many dormant insects revive a bit and fly or crawl about. The south-facing sides of rock outcroppings and stone buildings are likely spots. The entomological literature contains many descriptions of insects hopping or crawling on the snow on warm winter days.

Insects can also be found in buildings throughout the year. High sheltered areas are the best places to look. It is likely that the flies taking shelter in buildings during the winter produce most of the young that plague us in the summer. For insects that are parasites of warm-blooded animals, life is as usual through the winter.

ACTIVITY 42, Grades 5-8, Area A11

FOUR WAYS TO ESTIMATE HEIGHTS

THE SHADOW-RATIO METHOD

Place a stick of known length (yardstick) perpendicular to the ground and measure the length of its shadow.

Measure the shadow cast by the object to be measured.

Solve this proportion:

$$\frac{\text{Shadow of Object}}{\text{Shadow of Stick}} = \frac{\text{Object's Height}}{\text{Stick's Height}}$$

Example: 3 ft. yardstick casts 2 ft. shadow.
Tree casts 10 ft. shadow.

$$\frac{10}{2} = \frac{\text{Tree's Height}}{3}$$

Tree's Height = 15 ft.

USING 12:1 RATIO OR SIMILAR TRIANGLES

Measure 11 paces from the base of the object (tree) and push a stick into the ground.

Continue one pace farther and mark. Lie on the ground at this point and sighting with the lower eye, project a line past the stick to the top of the tree.

The height on the stick in inches where the projected line of sight passed is the height of the tree in feet. EXPLAIN!

USING THE ARTIST'S METHOD

Have a person whose height is known stand by the object to be measured. (a person who is 4 ft. 6 in., 5 ft., or 5 ft. 6 in. tall simplifies the computation.) This person is the "unit of measurement."

Hold a stick (or Pencil) at arms length. Sight over the top of the stick to the head of the "unit of measurement." Place the thumb-nail on the stick where the line of sight meets the foot of the person.

Determine the number of "units of measurement" fitting onto the object being measured by moving the stick upwards a unit at a time.

Note: A similar method is used to help to establish elevation concepts. Have the first child move down the trail until his eyes are at ground level with the starting point, the second person farther down the slope

Continuation of Activity 42.

until his eyes are level with the feet of the first person. Continue until each individual has been placed or the distance covered. Count the number of "units" (persons) to obtain the "depth." This TOTEM POLE method allows individuals to change places along the slope so each can look "back up".

THE ISOSCELES RIGHT TRIANGLE METHOD

Back away from the object (tree) until an imaginary line from your eye to the top of the tree forms a 45° angle to a horizontal line from your eyes to the tree. Use a clinometer (vertical protractor) to help determine the correct angle.

In a 45° triangle (isosceles right triangle), the two sides are equal in length, hence distance A is equal to distance B.

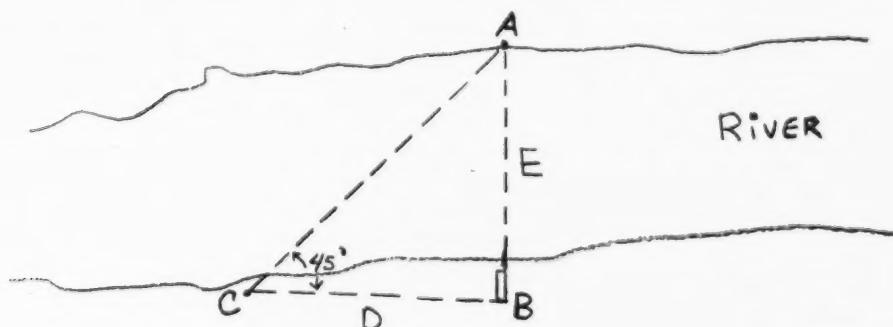
ACTIVITY 43, Grades 5-8, Area 0

*MEASURING THE WIDTH OF A RIVER USING A COMPASS
(and an Isosceles Right Triangle)*

Select a clearly visible point (A) across the river.

Mark your position with a stake (B) and walk along the edge of the river until you reach a point (C) at which a line from you to the point (A) on the other side will make a 45° angle to a line along the edge of the river. (Use the compass to measure the 45° angle.)

In a 45° (isosceles) right triangle the two sides are of the same length. (IN the illustration, distance D is equal to distance E.) To determine the width of the river, therefore, measure distance D between the points B and C.



Continuation of Activity 43.

Example: If the river runs north and south and you are on the east side, points A and C should be selected with a compass so that point A is 270° (azimuth) from point C. Then point B should be determined by going south along the bank until you get a compass reading of 315° ($270^{\circ}+45^{\circ}$) to point A. Measure distance D by pacing. If it is 200 feet, then the width of the river is approximately 200 feet.

ACTIVITY 44, Grades 5-8, Area all

CONSTRUCTING TEACHING COMPASS COURSES

Teaching Compass Courses may be used almost any place (school sites, camp sited, etc.) to develop concepts and understandings. Their essential features include:

1. Teaching stations and/or locations.
2. Comments, questions and activities at each station relative to what the learners are to observe, measure, do or accomplish.
3. Directions leading learners from station to station.

Teaching Compass Courses may have many purposes. These include:

1. To apply and develop compass skills.
2. To orient students to an area or to serve as an awareness exercise.
3. To provide identification experiences (trees, rocks, buildings, etc.).
4. To develop a concept (ecology, geology, similarities and differences, etc.).
5. To point out individual specimens or situations leading to generalizations.

Good compass courses require considerable work and time to construct. Hence, several leaders may wish to plan and develop an activity jointly.

1. Clearly define the educational purposes and objectives.
2. Select the stations and develop activities, data gathering, observations and questions applicable to each.
3. Determine the sequence of the stations in the compass course.

Continuation of Activity 44.

4. Develop directions to lead students from station to station:
 - a. Measure the distances (although children may pace these distances, their error will be sufficient).
 - b. Determine the azimuths from station to station. Check and recheck!
 - c. Provide hints to tell children if they are near to where they ought to be (Examples: "At your right is a chimney."
"Directly west of you is a swing.")
5. A course may be designed to provide directions for completing the entire course at the beginning or students may discover directions as they proceed from station to station.
6. Prepare the students beforehand (they may work individually or in small groups):
 - a. They should know the reason for the compass course.
 - b. They should know their step length.
 - c. They should know how to convert feet or yards to steps. (Here is an application of ratio and proportion.)
 - d. They should know how to use a magnetic compass.
 - e. They need pencils, paper, compasses and other apparatus.
7. Follow-up indoors.

ACTIVITY 45 , Grades 5-8, Areas all

SIMPLE MACHINES: OUT-OF-DOORS

Objectives: To provide direct experiences with simple machines (levers, block and tackle, inclined planes, etc.).
To clarify concepts and understandings and to develop appreciations about these devices.
To use simple machines to do work,

Materials: Poles, planks, rope, pulleys, blocks, posts, objects to be moved, etc.

Preparation: Discuss hypothetical situations and develop hypotheses for solving these problems. Sketch possible solutions for situations like the following:

1. To remove a person trapped beneath a fallen tree.
2. To move the butt of a fallen tree blocking a road.
3. To move a heavy object, such as a car, a distance of several feet

Continuation of Activity 45

4. To move a heavy object (that can't be rolled) a long distance.
5. To lift an object heavier than yourself higher than your head.
6. To lift a heavy bucket of water (or a person) from a well.

Activities: Find or "set up" situations like the following to solve and test the children's solutions:

1. Example: A heavy fallen tree must be raised. (Students will suggest using a pole or pry-bar.) Allow them to experiment to find a way to raise the tree--then raise it. Analyze the experiments Which were successful?

ACTIVITY 46, Grades k-3 Area ADEGOH

SPRING FLOWERS

At this age the student is more interested in seeing the flowers than he is in keying out the flowers. With this as a basic assumption show the students the slide series Wild Flowers of Powell County and show the students how to press flowers. The directions for pressing flowers is found with in the slide series.

Once the students have learned how to press flowers go through the slide series again to reenforce their previous learning and have each student pick a flower from the slides to find outdoors.

Let the students go to the area and find (one) flower of the type he is looking for. If he finds it let him bring it back to the school and press it.

As the flower is drying have the students look up information on the flower and have them write this on the back of the herbarium sheet. Fill out the proper information on the front of the sheet and glue the flower to it. Display this in the classroom with the other students flowers.

Some students will choose a flower that will not be found in the area. Make the student stick with his choice. Have him come back to the classroom and find out why he could not find the flower and have him put this on the display board as well.

At the end of the exercise have the students present what they found about his flower to the class.

ACTIVITY 47, Grades 4-6, Area ADEGOH

SPRING FLOWERS

At this age they should be able to handle a dicotomous key. The key that they will be using is a color key to the 50 most common flowers found in Powell County.

The aim at this age is to have the students learn to identify the flowers correctly. And start a school herbarium collection.

Show the students the proper way of pressing flowers using the slide series Wild Flowers of Powell County. After this has been establish and also the proper way to fill in the data, show the students the rest of the flowers in the series as a pre-field exercise.

Take the students to the outdoor area and have them key the flowers with out picking the flowers. Allow one student to pick one and put into a vasculium to take back to the school.

Work on this exercise as long as it seems desirable.

ACTIVITY 48, Grades 7-8, Area ADEGOH

SPRING FLOWERS

BACKGROUND: It is assumed by this time that the student can handle a larger key than the color key used for grades 4-6. This key has on it about 100 of the common flowers that can be found here in Powell County. It is not extremely hard, to use, but it is quite accurate for the flowers that are found on it.

PROCEDURES: Have the students view the slides on the collecting, pressing, and mounting of plant specimens. After they understand this, it might be good to bring in some plant specimens and have the students key them in class as a group to make sure that they all understand how to work the key. Flowers can be picked the day before and wrapped in wet paper towels and kept in the refrigerator for several days.

Next have the students go into the field and collect the specimens that they want and bring them back to the school. If time has run out, have them keep them in wet paper over-night and begin keying them the next day. Hand-lenses are available for the students. Once the flowers are identified, have the students press them while they work on others. Finally mount them and have the students start a school or class plant collection. The last few slides in the slide tray show how to start a school herbarium.

Practice is what makes perfect with keys. Because this key is only for 100 flowers, you will find in the kit one Booth key to all the flowers in the state and one Craighead book showing color photos.

Continuation of Activity 48-

EQUIPMENT: Plant Presses
Keys. student. teacher
Herbarium Sheets
Slides of Flowers

To add interest to this exercise have the student make a large classroom poster and record on it the first blooming date of the species that they find. After they have recorded all this information review the flowers with the students and see if they can develop some ideas why some bloom before others. Be sure and encourage the students to use reference books and materials in solving these questions.

ACTIVITY 49, Grades 7-12, can be modified for lower grades,
Area 0

THE STUDY OF A POND ENVIRONMENT

Concept: Organisms and the abiotic components of any environment are interdependent and a part of the food web.

Objectives:

Teacher- to help the students to understand that all organisms of a community, including man, are interdependent.

Students-

- (1). To recognize the tree basic groups of organisms which make up every community.
- (2). To observe the roles of these organisms in their environment.
- (3). To learn how to study an environment.
- (4). To relate changes in the environment to changes in the living organisms relationships.
- (5). To evaluate man's role in the maintenance of the environment.

The following guide is designed for either junior or senior high school use. The basic outline is as follows:

- A. Introduction of the concept and preparation of the class
- B. Planning the field trip
- C. Follow-up activities
- D. Appendix
- E. Bibliography

A set of large pond study cards are available through the center to aid you in this study as well as a film loop.

Continuation of Activity 49,

Introduction - Why Study a Pond?

To day man is concerned with the protection of the environment more than at any time in past history, and the reasons for concern are real. Some problems such as hunger and disease have always been present in the history of mankind. Others, covered by the broad term, "pollution", are of relatively recent importance and resulted from the greatly increased technological developments of the Twentieth Century which enabled man to exploit the earth at a much greater rate than ever before. One American is considered to be the equal of twenty natives of India-- as measured by the consumption of natural resources during his lifetime. Our industries, commerce, and households annually dump millions of tons of solid wastes and chemical pollutants into the water and air. As a result some rivers are so polluted that they have caught fire, and many persons with respiratory ailments have had their doctors recommended that they move from certain cities with bad air-pollution conditions. In recent years many new plants and animals have had their names added to the list of endangered species. This includes the blue whale, the largest animal which has ever lived on earth; and some biologists have even added man himself.

Why, then, study a pond to learn how to take care of our environment? Plants and animals are not randomly scattered around the earth but exist in highly complex communities which are determined by geology and climate. These communities can be classed as aquatic or terrestrial and then further subdivided into various land or water habitats. Life on land occurs from below sea level in such places as Death Valley and the Dead Sea to regions above timberline on our highest mountains. It ranges from tropical rain-forests, which have the greatest variety of species of organisms of any place on earth, to the Arctic tundra where only a few highly specialized plants and animals can live. Aquatic life is found in Ant-arctic seas so cold that some fish do not have red blood cells for the transport of oxygen while, at the other extreme, brightly-colored algae live in Yellowstone Park pools hot enough to cook flesh. But, in spite of the wide range of conditions under which life can exist, all habitats have a basic pattern in the composition of the life forms present. They consist of three inter-related groups of organisms essential to the maintenance of a balanced environment. These are the producers, the consumers, and the decomposers. A favorable habitat will have many species in each group; a severe one will have very few, but all three will be represented.

The producers are the green plants which contain chlorophyll and manufacture organic compounds through photosynthesis. The sun provides the original source of energy for this process even though many have gone through a number of energy transfers first.

The consumers are the predator-chains, the herbivores and carnivores which feed upon vegetation and upon each other. These chains may be very short, as in the case where man lives primarily on a diet of rice, or

Continuation of Activity 49.

they may be quite long and complex with many predators involved.

The decomposers are the microbes, the bacteria and the fungi which cause decay. They are the only living organisms capable of breaking down organic matter and recycling it so that it can be used once more in the food web. The decomposers are found in abundance a long the bottom of the pond, strewn in a thin layer where the mud and water meet.

They are also found in great numbers where plant plankton forms are abundant and in shallow water among emergent plants. Over two million bacteria may be present in one teaspoonful of bottom sediment. Foul-smelling gases may be produced as a result of the necessary activity of the decomposers, but decomposition of dead organisms is rapid in the favorable temperatures of ponds during the summer. It is the activity of the producers and the decomposers which determines the ability of the environment to support all other populations.

A pond contains an abundance of organisms in each of the three basic groups. Many of them are easy to collect and observe so that the study of a pond will help one to learn concepts which can then be applied to any habitat. The United States has over one and one-half million ponds. No two are ever quite alike, and no single pond ever remains the same for very long. Ponds may be natural or man-made. They may be temporary or permanent, but some type of pond is available in almost every part of the country for students to study.

Preparation of the class

- A. Physical characteristics of a pond habitat (1) (2)
size, depth, temperature, pH, light penetration, substrate
- B. Ecological niches--rocks, mud, logs, vegetation
- C/ Biogeochemical cycles (3)
- D. The web of life (1) (3) (4)
 - 1. Producers - algae; submerged, floating and emergent higher plants
 - 2. Consumers (first, second and third order)
protozoans, daphnia, cyclops, planaria, fresh-water shrimp, snails, clams insects, crayfish, frogs, birds, mammals, etc.
 - 3. Decomposers--bacteria and fungi
- E. Ecological pyramids - of number, biomass and energy(4)
- F. Supporting A.V. materials
 - 1. The Pond, International Film Bureau 16mm (c), 20'
 - 2. Under-Rock Environment, Ealing Film Loop #81-5886/1 color, 4' elementary \$21.50
 - 3. Plankton: Food Webs and Feeding Relationships. Harper and Row Film Loop #81-6850.1 color, 4' \$24.95

Continuation of activity 49.

F. Supporting A.V. materials cont.

4. Animal and Plant Communities: The Pond.(Interdependence of Living Things series) McGraw-Hill, Film Strip 1961

-
- (1) Amos The Life of the Pond
 - (2) Morgan Field Book of Ponds and Streams
 - (3) BSCS Green Version Biology
 - (4) Odum Fundamentals of Ecology

Planning the field trip (1) (2) (5) (6) (7)

- A. Materials needed:
notebooks, thermometer, nuts, jars, buckets, compass, tape
- B. Team assignments - to vary with amount of work
 1. Mapping - sketch pond- show directions, size, depth
(if possible), nature of surrounding area, vegetation types
 2. Environment - note indications of man's activities, including domestic animals, on the nature of the pond- estimate age of pond (young or old) from development of vegetation and amount of open water left- is it temporary or permanent, man-made or natural? source of water supply?
 3. Producers- collect and record nature of green plants and relative abundance- algae, mosses, submerged pond weeds floating forms, rushes, sedges, cattails, etc.
 4. Consumers-collect where possible, note abundance
 - a. Invertebrates - plankton, worms, mollusks, crustaceans, etc.
 - b. Vertebrates- fish, amphibians, reptiles, bird and mammals-note evidence of their presence from tracks, droppings, homes -plaster of paris casts of footprints can be made
 5. Decomposers - collect bottom sediment and pieces of debris and vegetation for bacterial cultures
 6. Water chemistry, temperature, color, odor, (pH, methyl orange alkalinity, oxygen content) (8)

Follow-up activities

- A. Bulletin board display-current articles and pictures on ponds and pond ecology.

Continuation of Activity 49.

- (1) Knudsen Biological Techniques
- (2) Morholt et al A Source Book for the Biological Sciences
- (3) BSCS Field Ecology Lab Block
- (4) Welch Limnological Methods

B. Laboratory

1. Observe living organisms in aquaria and with micro-projector
2. make a home-made pond (1)
3. Separate producers and consumers into major taxonomic groups as far as possible.
4. Use bacteriological culture media to demonstrate presence of decomposers

C. Class-room

1. Distinguish between different levels of consumers
2. Diagram individual food chains
3. Diagram a food web with all organisms accounted for
4. Discuss the following:
 - a. How do seasonal changes affect the food web?
 - b. Why are there so many different kinds of organisms?
 - c. Why are herbivores more abundant than carnivores?
 - d. Why are most life cycles short?
 - e. What changes will occur if--
 - (1) an herbivore is removed from the web?
 - (2) a carnivore is removed from the web?
 - (3) cattle start using the surrounding area and drink from the pond?
 - (4) the land is plowed up the edge for crops?
 - (5) a feed lot drains into the pond?
 - (6) a class visits the pond yearly for study?
 - (7) a class visits the pond daily?
 - (8) the pond is filled in?
 - (9) all ponds are filled or drained?
 - f. Any questions which fit local conditions

Suggestions for the Teacher

Allow adequate planning and preparation time to insure success of the field trip.

Obtain permission from school administration and parents of students, arrange for transportation, and secure additional supervisory help well in advance of the trip.

-
- (1) BSCS Investigation 6.2

ACTIVITY 50, Grades 1-8. Area ADHOEG

ANIMAL TRACKING

An aspect of an outdoor animal study that promotes group interest and involvement is reading animal tracks and preserving them in plaster. The following are tips for working with children on experiences of this nature.

READING THE TRACKS (TRACK DETECTING)

Begin by having the group discuss where they are likely to find tracks. Generally, more tracks will be found in a particular location, such as along the river. Animal trackers should realize that upon discovering tracks, care should be given so that none are damaged. Questions like the following may be used for group discussion to help stimulate interest and curiosity.

Single Tracks:

- How long is the track?
- How wide is the track?
- How many toes on the forefoot?
- How many toes on the hindfoot?
- Is the track fresh or old?

Group Tracks:

- What direction was the animal traveling?
- Was the animal walking or running?
- Does the animal continue at the same speed?
- What other signs of the animal are there?
- What are the feet adapted for (climbing, grasping, running)?
- What kind of food would this animal eat?

After the group has made a thorough investigation of the tracks, each individual should have an opportunity to take home a souvenir track.

PRESERVING THE TRACKS (PLASTER CASTING)

Although there are various suggestions for making plaster casts, the following is a proven technique used with groups of 8 or 10.

Equipment Needed (group of 8 or 10)

- 3 tin cans (#10 size) with plastic tops
- Construction paper, strips of file folders, etc., cut in strips about 1½ inch wide to make collars.
- 10 paper clips.

Continuation of Activity 50.

PROCEDURE:

1. Select track and position a strip of construction paper around it making sure the collar is tight to the ground so plaster will not seep out.
2. Pour plaster (#10 size can holds enough plaster for about 10 tracks) into mixing can, then add water and stir until it reaches the consistency of pancake batter. Be careful that too much water is not added since you will have a limited amount of plaster in the field with you (ratio-- approximately two parts plaster to one part water).
3. Quickly mix and pour into tracks (the plaster will begin to set within a few short minutes).
4. Before the plaster is completely hard, shape a paper clip to serve as a hanging hook and secure into back of plaster.
5. After plaster has hardened (1 to 3 hours), remove slowly and clean off collar, disposing of paper in empty can.
6. Clean the cast with a paper clip or an old brush.
7. Mounting the cast to backing board makes an attractive decoration.

TIPS:

Casts of leaves and flowers may be painted with poster paints or oil paints.

Talcum powder sprinkled on the track will keep the cast from retaining sand or mud.

Salt may be added to the mixture to hasten setting, vinegar to slow down hardening.

ACTIVITY 51, Grades 1-8, Area ADHOEG

ANIMAL TRACKS

Animal tracks may be found on sand, dust, mud, and snow. Most wild animals are nocturnal coming out at night and only rarely are they seen in the daytime. Thus this procedure can aid you in identifying animals that you might not otherwise know that they are there.

Identification can be made by matching and comparing the clear track found in the field with the inclosed tracks here. You will notice that there will be variation for it is almost impossible to show what a perfect typical track for any particular species looks like for they vary in size, surface upon which they were made and the speed that the animal was traveling when it was made.

Animals who are mainly tree dwellers bound along on the ground placing their feet side by side on the ground with each bound. The hind feet strike the ground after the front feet on the ground beyond the marks left by the front feet.

Ground dwelling animals strike the ground with their front feet placed diagonally one ahead of the other at each bound. The hind feet hit the ground beyond the marks of the front feet.

Field work

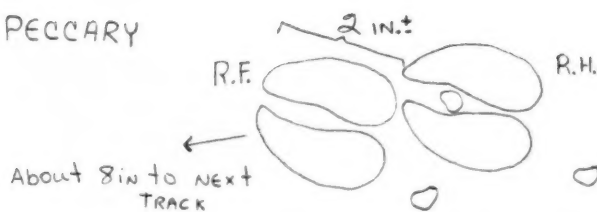
Once a track is found in the field the following should be done to insure a good plaster cast.

Remove all sticks and stems from the track. Clip a cardboard strip into a circle large enough around the track to give room on all sides.

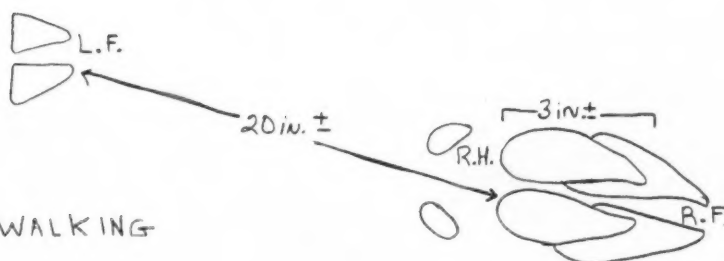
Pour enough water into a can to cover the track by more than an inch. Gently sift the plaster into the water making a mixture as thick as pancake mix. Thumb the containers from time to time to make the air bubbles rise and then pour the mixture into the track. Allow the plaster to run into the deeper parts, never pour directly into it. If the cast is large reinforce it with sticks. Allow the plaster to harden, and then tear away the cardboard strip. Wash mud and earth from cast which can be colored later.

Once the cast is made it can be paintd realistically and the background information on the animal secured.

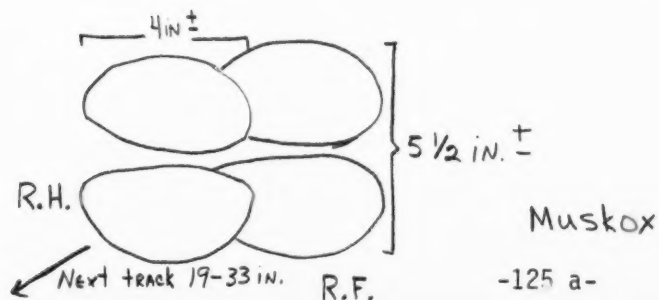
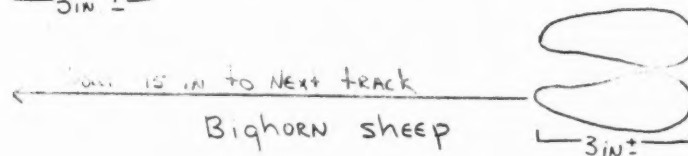
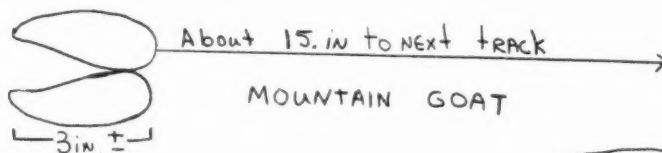
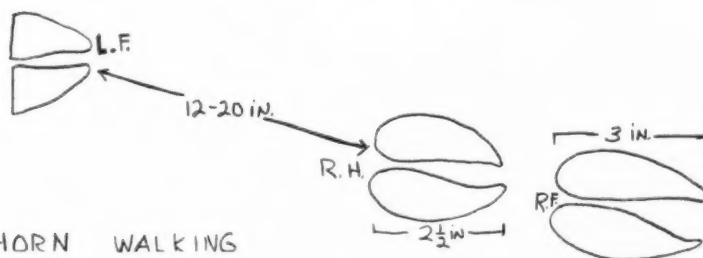
PECCARY



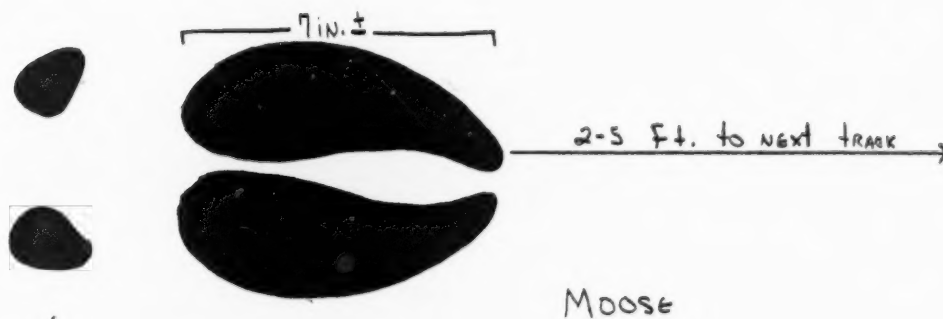
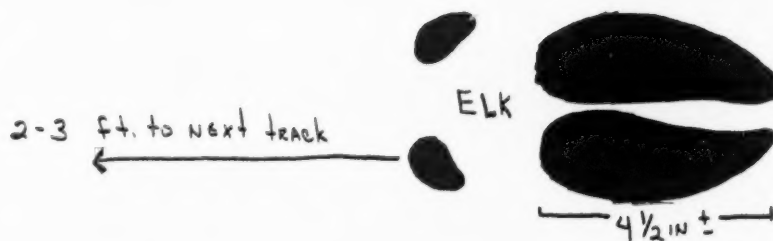
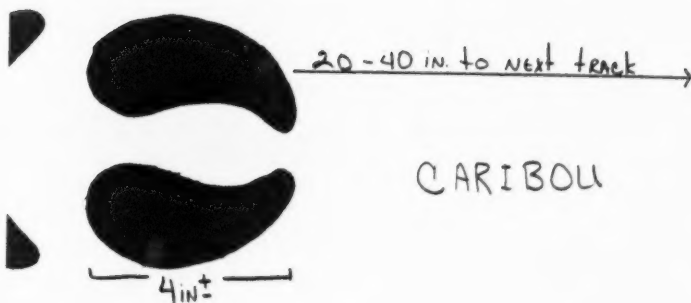
DEER WALKING

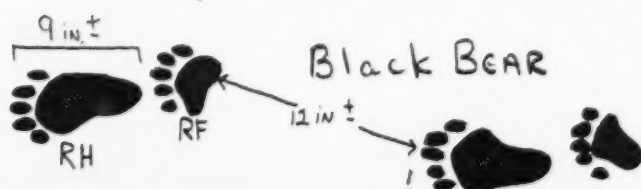
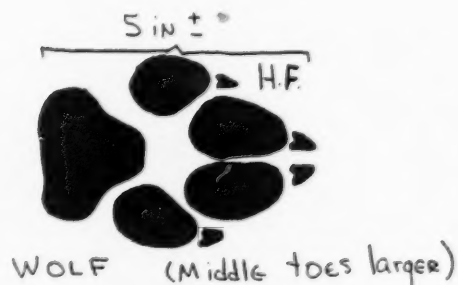
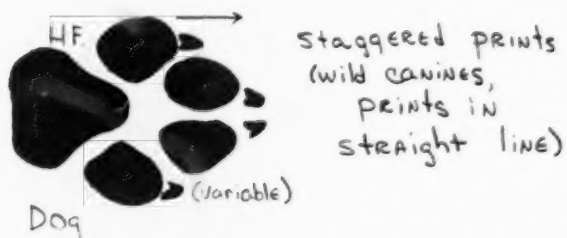
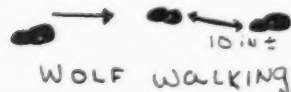
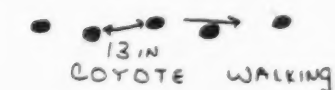
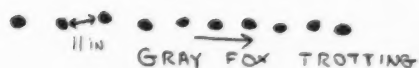
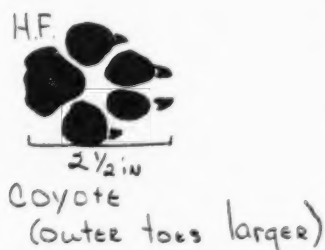
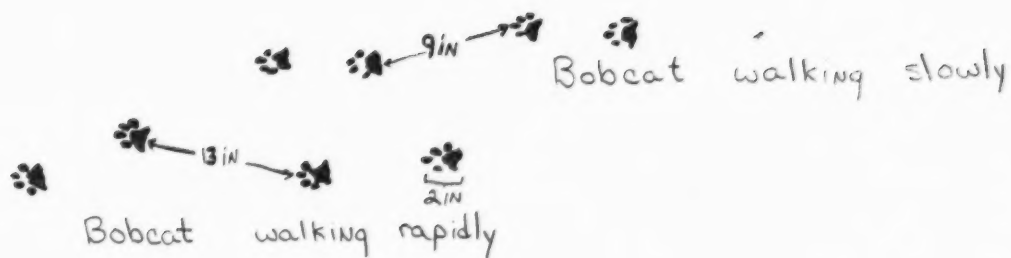


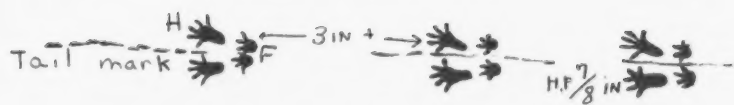
PRONGHORN WALKING



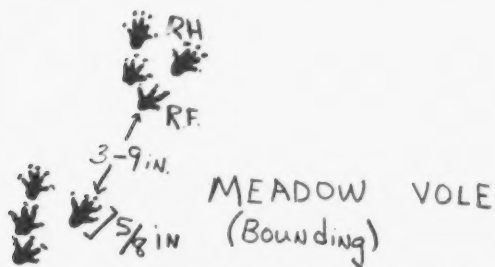
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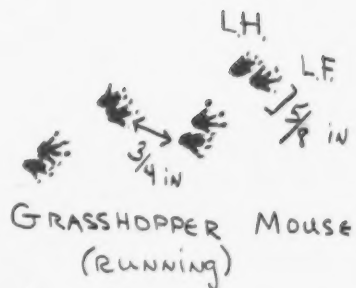




DEER mouse



MEADOW VOLE
(Bouncing)



GRASSHOPPER MOUSE
(Running)



KANGAROO RAT



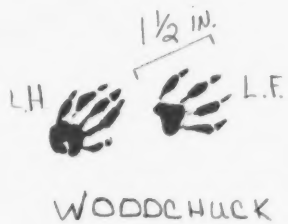
Shorttail
shrew
(foraging)



NORWAY Rat
(walking)



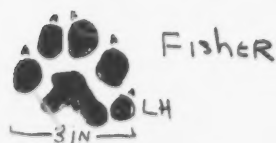
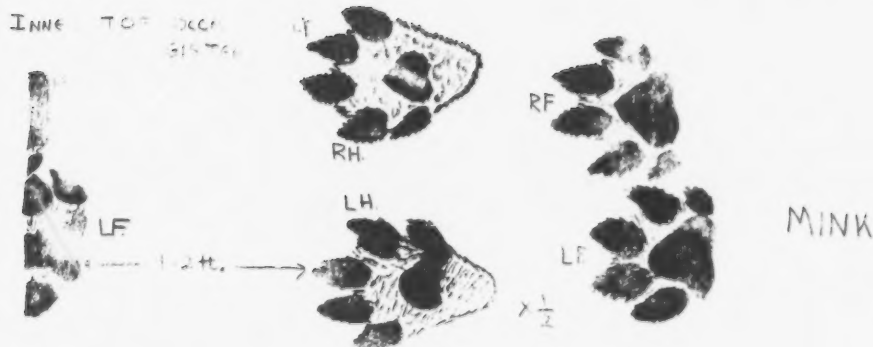
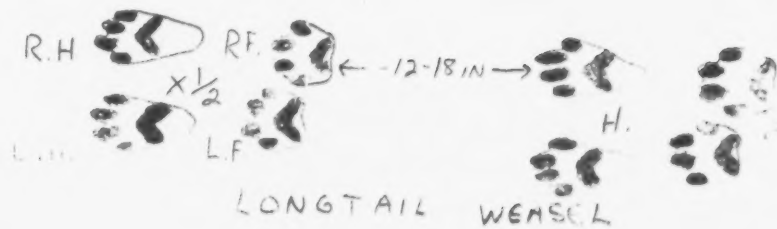
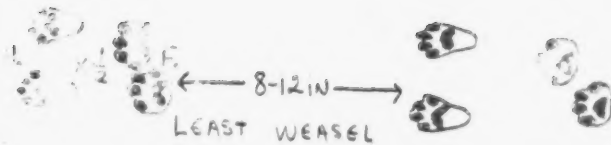
RACCOON

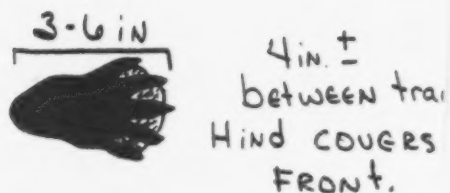
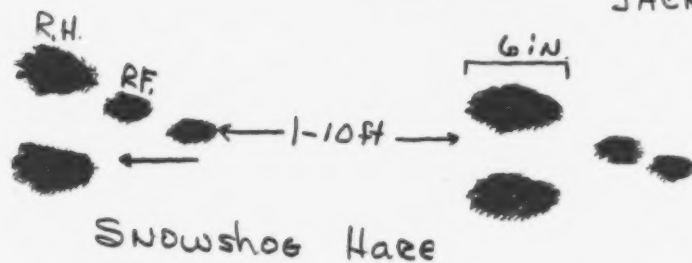
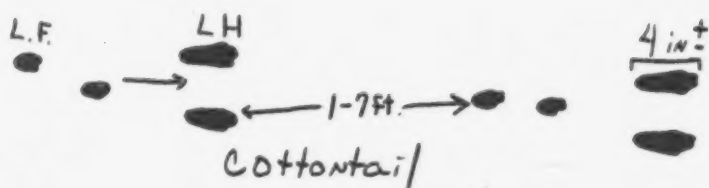
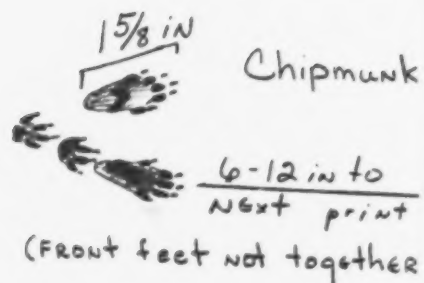
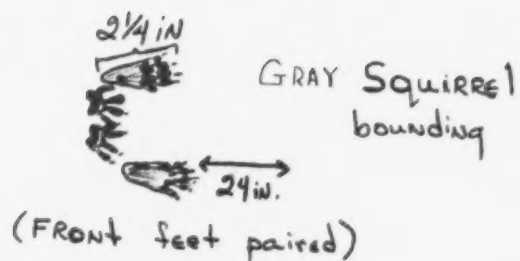


WOODCHUCK



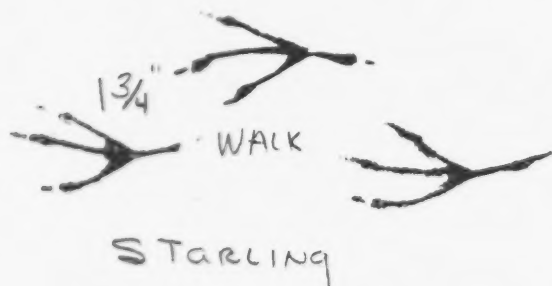
Badger







PORCUPINE



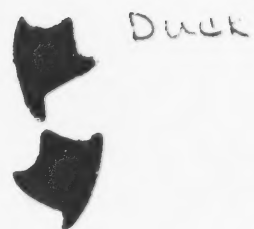
STARLING



SPARROW



ROBIN



ACTIVITY 52, Grades-can be incorporated for all, Area-all

INTERPRETING ANIMAL TRACKS
(INDOOR EXERCISE)

Interpreting animal tracks can be very interesting and fun for students in all grades.

Outdoors it may be difficult to find a complete set of tracks which tell a "story" so we suggest that you try this method of track "stories" or interpretation.

1. Draw a simple set of tracks which show the path of an animal and what he encounters in his natural habitat. (An example is included in this activity.) These tracks can involve few or several animals depending on the grade level using the activity.
2. Have the student interpret the "track map" and write his story down. Students may come up with several stories which is fine, this encourages creativity.
3. Ask questions on how the students came up with their stories. Discuss with the students the different opinions they have.

SuggestionS:

Let the students try to think up and draw their own track maps. Have them exchange maps and interpret each other's. This also could be done as an art project or English assignment.



What animals are involved?

(man & skunk)

What caused the change
in direction?

ACTIVITY 53, Grades 5-8, Areas -all

MAKE YOUR OWN SEISMOGRAPH

The earth has been likened to a great bell which vibrates over its entire surface when struck at any point. Seismographs are used to record earth vibrations caused by internal disturbances. Refined instruments can be used to locate the source of a disturbance and to identify several different types of seismic waves.

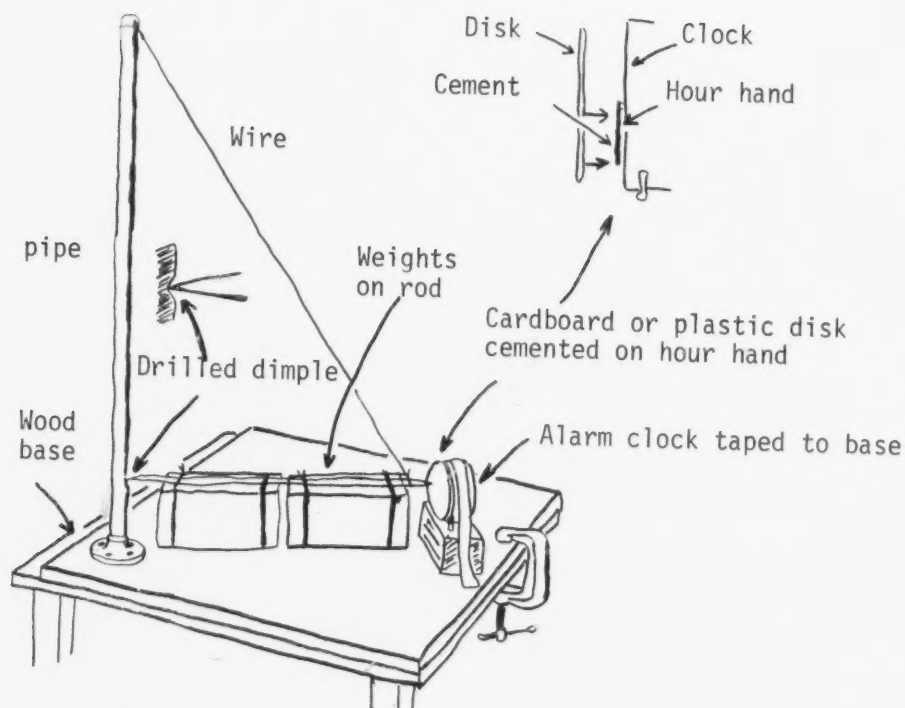
A seismograph for recording strong earth vibrations or strong local vibrations can be constructed rather simply. First secure a heavy flat wood base, about 3' by 2' by $\frac{3}{4}$ ". Secure the base to a table by means of a C-clamp. At one end of the base, fasten a pipe flange by means of heavy wood screws, as shown in Fig. 3. Into the flange, screw a 3' length of pipe ($\frac{1}{2}$ " to $1\frac{1}{2}$ " dia.) threaded to fit. About $4\frac{1}{2}$ " above the base of the pipe, drill the small dimple that is the beginning of a hole. Do NOT drill all the way through. Next, take a 20" length of $\frac{1}{4}$ " diameter metal rod, and file both ends to a point. Fit one end into the dimple in the pipe. Suspend the rod in a horizontal position by connecting its far end to the top of the pipe with a length of No. 14 steel wire. From the horizontal rod, hang sash weights or heavy bricks attached by wire or tape.

To improvise a recording disk: Obtain a working spring-wound alarm clock. Remove the minute hand. To the hour hand, glue a thin cardboard disk. Soot the disk with a candle flame, but be careful not to ignite the disk. Place the clock so that the point of the metal rod just touches the soot on the disk at about the nine o'clock position. The rod will register local vibrations on the dial. Jumping in the room and other strong disturbances, such as may be caused by heavy trucks passing on a nearby street, will be recorded.

List of Materials

1. A heavy, flat wood base about 3' x 2' x $\frac{3}{4}$ "
2. A C-clamp
3. A 4-hole flange, to accommodate threaded pipe
4. Four wood screws to fit flange
5. A $\frac{1}{2}$ " to $1\frac{1}{2}$ " diameter pipe, 3' long, threaded at one end
6. Center punch or drill press
7. A $\frac{1}{4}$ " diameter steel or brass rod 20" long
8. Coarse file
9. Four feet of No. 14 steel piano wire
10. Bricks or heavy sash weights
11. An old, working spring-wound alarm clock
12. A cardboard disk about $\frac{1}{16}$ " thick, 4" in diameter
13. A candle

Continuation of Activity 53.



ACTIVITY 54, Grades 1-8, Areas all.

USE "WEATHER" TO TEACH CHILDREN TO OBSERVE,
RECORD AND PREDICT

Although "weather" is the subject of many elementary school and camp units, teachers and campers rarely utilize local weather conditions as effectively as they might. Here is a nearby source for observational, data gathering, involvement and predictive experiences.

Local weather conditions are a useful resource for investigations because:

1. Weather contains conditions to be observed and measured-- temperature, barometric pressure, precipitation, wind direction and speed, relative humidity, cloud type and cover.

Continuation of Activity 54.

2. Weather conditions change from hour-to-hour and day-to-day, thereby providing variety in the observations and the data recorded. Sometimes these conditions appear to be related to each other, at other times they appear unrelated.
3. Some conditions such as barometric pressure and temperature can be readily observed and measured; but others such as cloud type and cover are less subject to measurement and observers have to make judgments when recording conditions.
4. Children can be actively involved in observing, measuring and recording conditions. They can position and read some instruments and manipulate others.
5. Converting the data recorded on an hourly or daily basis to long-term generalizations or descriptions provides applications for many indoor understandings about weather, graph construction, basic statistics and the like.
6. Pupils' predictions are put to a test within a short time.
7. Children can feel and directly experience the conditions they measure.
8. Apparatus and instruments are relatively inexpensive, easy to use and require little storage space.

A group of children might wish to seek answers to problems or studies such as the following:

1. Recording weather conditions on the school or camp grounds over an extended period of time and comparing with conditions reported at an official weather station nearby.
2. Making comparisons between conditions at various points on the site,
3. Determining the effect of weather conditions on human beings. (Is temperature the only factor making it feel "cold"?)
4. What do people really mean when they use terms such as "nice day", a "stormy day", a "miserable day", and so on?
5. Determining which month (or week) of the year has the most or least variable weather.
6. Identifying and testing relationships between weather and other factors such as the activity of insects and birds, operation of the heating plant, inside relative humidity, way people dress, etc.

Continuation of activity 54.

Obviously the children's questions will be the source of additional problems to be solved first-hand. Hopefully, many will turn to first-hand observation to obtain answers to questions and to test possible explanations. Subsequently, they will have to use many research techniques and will want to construct graphs and use other techniques to clarify and picture their data.

Groups undertaking weather studies should have their own kit of instruments so observations can be made without interference and instruments will be conveniently available when needed. Included should be (1) an aneroid barometer, (2) inexpensive psychrometers, (3) inexpensive household thermometers, (4) wind speed and direction indicators and (5) reference materials such as relative humidity tables, Beaufort wind scales, cloud charts and data recording sheets.

Approximately \$25.00 should be sufficient to purchase these instruments. Since children sometimes mishandle instruments, relatively inexpensive hardware store items serve as well as expensive scientific items. Classroom constructed apparatus will often suffice.

Fixed indoor weather stations being installed by many schools and camps so that outside conditions can be obtained without going outdoors have the inherent disadvantage of removing much of the activity or pupil involvement from the process. Pupils do not get to experience the conditions they measure or study. There is a distance difference between standing indoors and recording information about a cold wintry blizzard and going outdoors in the storm. Children should directly experience the elements as they measure them. Additional emotional or affective objectives of teaching are attained in this manner.

Activity 55, Grades 1-8. Areas all.

WEATHER EXPLORATION

Goal: The students will learn about some of the basic weather factors, ways of measuring such factors and various pertinent learning techniques.

Purposes: To help the students discover some of the components of weather.
To develop some simple weather instruments.
To acquaint the students with appropriate techniques emphasizing pupil involvement in observation, data gathering and interpretation.

1. Visit a weather station to introduce students to instruments commonly used in measuring weather data.

Continuation of Activity 55.

- a. What are some basic weather elements? Define the following as completely as possible:

- | | |
|-------------------------|----------------------------|
| (1) Wind | (5) Clouds |
| (2) High pressure | (6) Temperature |
| (3) Low pressure | (7) Air mass |
| (4) Humidity (relative) | (8) Cold front, warm front |

- b. On the basis of these definitions and observations, try to make some simple instruments that will measure some of the components of weather:

- (1) Wind vane: feather in cork or cardboard vane.
- (2) Bottle with balloon and pointer: what does this measure?
- (3) Wet and dry bulb thermometers.
- (4) Beaufort scale for wind speed.

2. What are some of the considerations necessary in making a weather prediction?

Consult the following section, "Weather Forecasting Information", and current weather maps.

3. Establish a list of weather facts which you can observe now. On the basis of these facts, what do you think is likely to happen weatherwise in the next 24 hours?

WEATHER FORECASTING INFORMATION

Each observer forecasts the weather using his own observations in conjunction with preceding reports. Forecasts are often based on rules and relationships like the following from various sources:

1. A falling barometer indicates an approaching "low" with a storm.
2. A rising barometer indicates the passing of the "low" and the approach of a "high" and fair weather.
3. The passing of a "low" in summer will be followed by warmer weather.
4. The passing of a "low" in winter will be followed by colder weather, perhaps with a "cold front" blowing from the "Far North" and with blizzards in regions east of the Far West.
5. Winds from the south or southeast foretell a "low" coming from the west with its center to the north of the observer, and with rain to come within 24 hours.
6. Winds from the east or northeast foretell a "low" coming from the west with its center to the west or to the south of the observer, often with heavy, chilly rain and cold weather.

Continuation of Activity 55.

7. Winds swinging from the southeast to the southwest indicate that the center of the "low" has passed to the east and that fair and colder weather will soon follow.
8. Winds swinging from the east or northeast to the northwest also indicate that the center of the "low" has passed to the east and that fair and colder weather will soon follow.
9. Cirrus and cirro-stratus clouds, coming from the west with a gray sky, indicate the approach of a "low" with a storm.
10. A bright blue sky with cirrus wisps and with the wind in the west or northwest will be followed by fair weather for 24 to 48 hours or longer.
11. A bright blue sky with numerous cumulus clouds may be followed by strato-cumulus and rain or snow flurries during the middle of the day and early afternoon, but fair at sunset.
12. Calm, humid, warm to hot days during the spring often produce thunderstorms.
13. If the lightning of a thunderstorm appears to the northwest, west or southwest, the thunderstorm will come nearer the observer and perhaps pass over head.
14. If in fall or spring the temperature falls at the end of a clear, calm day to 40° or 45° , one may expect frost in low places by morning.
15. Frost will not form under the conditions in (14) if clouds cover the sky before the morning or if a wind of any sort blows during the night.
16. Dew will form at night if there is no wind and the sky is clear so that ground heat may be radiated to space.

Things to measure are:

- Time of day
- Temperature (5' above ground)
- Temperature at surface
- Wind direction
- Wind velocity
- Barometric pressure
- Relative humidity
- Ppt (rain-snow) since last reading
- Clouds--type and per cent cover
- Adjectives descriptive of weather at the time of observation
- Relationships noted between readings
- Generalizations

ACTIVITY 56, Grades 3-12 , Area ADEGHO

LESSON PLAN OUTLINE
FOR THE USE OF THE MAP & COMPASS
IN ENVIRONMENTAL INVESTIGATION

A. Pacing and the Compass

A compass is used for determining directions on the earth's surface. By using a compass and knowing the length of his step, a person can determine distances and directions of many objects.

1. Pacing - A pace is the distance covered on the ground when a person takes two steps, OR, it's the distance covered when a person picks up his left foot until he puts it down again.

TASK A

Determine the length of your step by using the attached card. Check your accuracy by pacing to two objects indicated by the instructor.

2. The Compass-- Parts

- a. Baseplate - Clear plastic, has direction of travel arrow and two different scales.
- b. Azimuth ring (compass housing)- A dial with degrees marked on the top. Has the four cardinal directions marked, plus orienting arrow inside the bottom of housing (moves when ring moves).
- c. Magnetic needle-Pivots freely within the azimuth ring. Red end always points to magnetic north.

TASK B

Orient the compass by rotating your body until the magnetic needle and arrow in azimuth ring (compass housing) are superimposed.

3. Declination- Declination is the difference between true north (north pole) and magnetic north (around Hudson's Bay). Maps are always made to true north.

The difference between the two in western Washington is about 22° . The compass can be adjusted to true north by subtracting 22° from 360° (338°) and setting this on the direction of travel arrow. DO NOT MOVE AZIMUTH RING ONCE THIS IS SET. On the base plate in line with the 360° mark, put down a small piece of scotch tape. Mark a line on the scotch tape in line with the 360° .

Continuation of Activity 56.

TASK C

Orient yourself to magnetic north.

From now on set and read all bearings on this pencil line (etched azimuth line)/ Always follow direction of travel arrow.

4. Field Application

TASK D

Orient yourself to true north.

TASK E

Orient yourself to the four cardinal directions using true bearings.

TASK F

Sight on given objects and orient your compass.

+

TASK G

Select a partner and check skills learned.

1. Each give partner compass bearing to set.
 2. Each give partner object to sight on.
- check for these things:
1. Compass held level.
 2. Red needle and arrow in compass housing superimposed.
 3. Set reading on pencil line.
 4. Follow direction of travel arrow.
 5. Sight on object to hike to.
 6. Read bearing on pencil line.
-

TASK H

Complete the attached Boy Scout Compass Course. Complete 2 out of 3 of the courses within a 5' error.

Continuation of Activity 56

B. Instant Mapper

1. Instant Mapper Construction

- a. Using cardboard as base, sandwich an azimuth sheet with clear plastic adhesive on cardboard. Seal edges with masking tape.
- b. Center acetate disc over azimuth on sheet. Pierce acetate and other cardboard with icepick or knife.
- c. Draw short radius on outside edge of acetate circle using compass baseplate as straightedge.
- d. Attach a short piece of masking tape to the outside of the acetate disc to use as a handle.

TASK A --Construct an instant mapper.

2. Use of an Instant Mapper- The instant mapper is just like a compass with the added advantage that you can write on it, thereby showing where you are going or where you've been.

TASK B

Using the instant mapper, plot the two given three sided traverses:

1. 346° for 102'
 129° for 78'
 215° for 63'
2. 38° for 125'
 237° for 90'
 183° for 50'

a. By using the penciled line on the azimuth ring as a direction arrow, set your first azimuth reading. Pick any spot on the acetate ring, make a small dot and number it "1".

c. At the end of your distance, put a dot and number this "2".

d. Now use the pencil line on the acetate ring to set another azimuth reading. Draw a straight line as before, beginning at point 2.

Remember, always toward the N-marker and parallel with the edge of the paper. Number the end of the second line "3".

e. Repeat until all azimuth bearings and distances have been used.

Continuation of Activity 56

3. Field Application

TASK C

Plot one of your own traverses from the Boy Scout compass game (hint: use one that may have been difficult for you to do.)

TASK D

On the attached sheet with known traverses, prepare a nature trail map to include these things:

1. Observation of each station.
 - 2/ Derive questions about the observations which will involve students.
 3. Include on map: scale Legend
 date Title
 North arrow Map makers names
-

C. Plane Table Mapping

A plane table is a device for mapping an area without using a compass or much measuring. Only one measurement is needed -- that of a base line. All objects to be mapped are then located by triangulation or the intersection of two lines.

1. Plane Table Construction

- a. Place cardboard boxes one on top of the other, Thread boxes together with stout cord.
- b. Tape paper to the top of the box.
- c. The 12: ruler will be used as a sighting guide. Drive map tacks into the ruler making sure tacks are equidistant from one edge of the ruler.

TASK A

Construct a plane table

2. Use of a Plane Table

- a. A minimum of two people and a maximum of five should be used.
- b. Pick the two objects to be included in the map that are the farthest apart. Set up your boxes near one of these objects to be included in the map.
- c. Drive a red flagged stake at the base of the boxes. Then pace the longest distance that must be mapped and drive in the other stake. On the way back to the plane table, pace the distance. THIS IS THE ONLY MEASUREMENT NEEDED.

Continuation of Activity 56

- d. Orient your map in the direction of this line. Draw this line on your map -- remember to make a scale. For instance--
1" = 100' Then on a paper 8" wide, a space 800' wide can be mapped.
1" = 40' On a paper 8" wide, a space 320' wide can be mapped.
1" = 20' Space 160' wide can be mapped.
- e. Label the location of you box "point 1". Label the far one "point 2"
- f. Lay the ruler so that one edge is along the points on the paper. Now turn the box so the tacks on the ruler sight from the point 1 to point 2. This orients the plane table correctly with the base line. The map must continue to be aligned with this base line during all future mapping.
- g. Keeping one end of the ruler at point 1, rotate the far end as you sight along the tacks until you see the object to be mapped (tree, building corner, telephone pole, etc.). Draw a line along the ruler extending to the edge of the paper. Label this line what you sighted.
- h. Repeat until you have sighted all the objects you want from point 1. You will, on your map, have a number of lines radiating from point 1.
- i. Now move to point 2 on the ground and orient your map back to point 1. Make sure map, box and you are at point 2 looking at point 1.
- j. Take sights on objects sighted at point 1. Where they intersect, you can draw the object (tree, corner of building, etc.).

TASK B -- Using the plane table method, map an area using any combination of roads, trees, etc. Include at least five objects.

3. Check - As a check of your accuracy, you may want to pace to a couple of objects and check your map scale to see if they are the same. This is not necessary for the exercise.

4. Field Application

TASK C-- Determine a given unpaceable but known distance.

When you are finished add the following to complete your map:

Scale	Title
Date	Legend
North arrow	Map makers

Continuation of Activity 56

D. Summary of Processes

What are some of the processes that we have used during the exercise:

Observing
Classifying
Measuring
Predicting
Inferring

Communication
Formulating hypotheses
Experimenting
Interpreting
Making models

E. Behavioral Outcomes in Knowledge

1. As a result of these activities you should be able to:
 - a. Compute the length of your average step, given a premeasured 100' distance.
 - b. Using the length of your step, determine the dimensions of any given room, building or paceable dimension.'
 - c. Identify three major parts of the compass.
 - d. Demonstrate your knowledge of the compass by accurately setting a given bearing and following that bearing for a short distance.
 - e. Demonstrate your knowledge of ghe compass by sighting on an object and setting the correct bearing and following that bearing for a short distance.
 - f. Complete a traverse consisting of three bearings and three distances within a 5' error.
 - g. Construct an instant mapper.
 - h. Using the constructed instant mapper and determining the proper scale to use, you can accurately map a three sided traverse within a five foot error.
 - i. Using the constructed instant mapper and determining theproper scale to use, you can lay out and map a six-sided nature trail.
 - j. Construct a plane table.
 - K. Using a constructed plane table, you can accurately map a predetermined area and include at least three reference points.
 - l. Using a constructed plane table, you can measure a nonpaceable distance.

Continuation of Activity 56.

F. BEHAVIORAL OUTCOMES IN FEELINGS, AWARENESS, VALUES, ACTION

1. As a result of these activities you should be able to:
 - a. Describe your feelings about your ability to use a compass.
 - b. Write an analogy between your security blanket and the compass.
 - c. If so (above), describe why you feel more secure in the forest with a knowledge of how to use a compass.
 - d. What value would the instant mapper have in school sight development.
 - e. Compare the advantages of using a plane table or an instant mapper.
 - f. In which cases do you feel you would use each.

G. Equipment Needed

1. Map and Compass

21 stakes - numbered consecutively
100' tape
Plastic flagging
Silva compass (one per student)
Pencils with erasers
Scotch tape
Boy Scout compass game with answer sheet
Length of step sheet
Step-feet conversion sheet
Willamette stone sheet

2. Instant Mapper

Cardboard 8½" x 11"
Clear contact paper 8½" x 11"
Paper fasteners
Azimuth sheets 8" x 10½"
Masking tape
Scissors
Ice pick
Acetate discs (7" diameter)
(Herculene drafting film
matte finish one side,
.003 thickness)

3. Plane Table

Cardboard cartons
(3 per group)
Unlined paper 8½"x11"
Wooden 12" ruler (1 per group)
Map tacks (4 per group)
Masking tape
Pencil with eraser
Plastic flagging-
2 colors
Heavy twine
Stakes (2 per group)

ACTIVITY 57. Grades 1-10, Areas ADEGOH

MUSHROOMS

This unit is devised so that it gives the student some background on mushrooms and how to make mushroom prints.

This can be a very exciting unit and class collections can be made.

Mushrooms are plants called Fungi, a group that includes molds and yeasts. They contain no chlorophyll and are therefore unable to manufacture their own food. They are dependent on organic matter for their sustenance. The fungi which depends on dead material are called Saprophytes. Ecologically they are important because they complete the cycle of life, growth, death, and decay by returning to re-use materials removed from the soil by plants.

Fungi which feed on living material, plant or animal, are called Parasites. Although they need organic matter, moisture and warmth, fungi are independent of sunlight and are not restricted by latitude or altitude. The same species may be found from arctic tundra to tropical rain forest. The word "mushroom" is, in general, used to designate the fruiting portion of a fungus, particularly one with a cap and stem.

The study of mushrooms is called Mycology. Mushroom plants have no real roots, but have threads of Mycelium that forms a mold-like network from which the mushrooms grow, as fruit grows on a plant. This mycelium is truly the mushroom plant. Mushrooms reproduce by spores which are less complex than seeds. Spore color is an aid in identifying mushrooms.

An ordinary mushroom can release about a million spores. When a spore falls in a suitable location it absorbs water, swells, and begins to grow. There it puts out an amoeba-like extension of mycelium which spreads by sub-dividing and branching for weeks or months, and eventually forms buttons which later become the mature fruit. In the button stage one mushroom is much like another. When there is enough moisture, usually after a rain, the stem pushes the cap above the ground. The cap expands, exposing the gills.

Most commonly known mushrooms have a cap and a stem, although some species do without the stem. It is on the underside of the cap that spores are suspended on microscopic, club-shaped organs called Basidia.

Many stemmed mushrooms display, as a ring or collar around their stems or as filaments on the margin of their mature caps, remnants of a partial veil that encloses their gills in infancy. In the button stage some mushrooms are entirely enclosed, as well, in a universal veil which ruptures as the mushroom emerges. Occasionally bits of this universal veil remain as parts or scales of the mature mushroom cap and/or as a cup (volva) at the base of the stem. Every mushroom must be carefully examined for a cup and a ring since this is an identifying feature of the genus Amanita, which contains the most poisonous types.

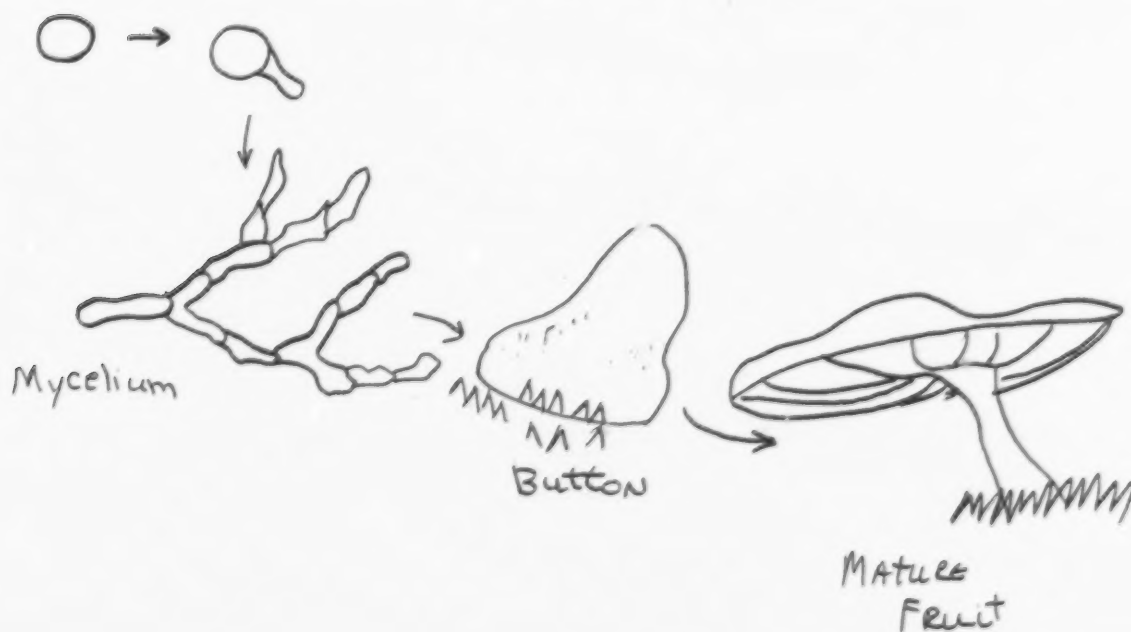
Continuation of Activity 57.

In addition to the cup and ring, the shape of the cap, the arrangement and attachment of the gills and the position of the stem are important characteristics to note for identification. (see drawings)

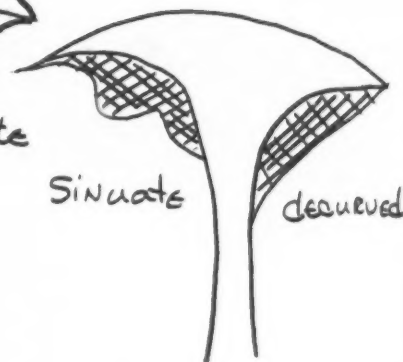
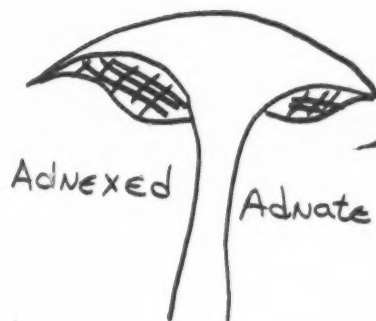
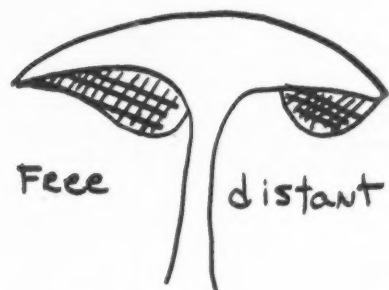
Do not experiment with mushrooms. One bite of *Amanita verna* practically guarantees death. Be sure to identify each mushroom you may pick. Just because mushrooms are growing together is no indication that they are the same species. Keep species separate when picking. The spore of one may be more toxic and contaminated than the others. When trying a new type, eat just a few in case you are allergic to that type. Gather fresh mushrooms with no carvae in the stem or gills. Break open the cap and split the stem lengthwise. There will be little tell tale holes and tunnels if carvae are there. Be sure to dig up all the base so you can tell if there is a cup surrounding the stem. Take an extra mushroom for a spore print the first time.

Balarat Mushrooms can be found in the meadow and under the trees. Some have symbiotic relationships with specific trees such as the douglas fir. A Notebook is a recommended project. Write down your findings. Write down in addition to the date and place, how it grows and where it grows, whether in the open, meadow, under trees, high and dry or low and boggy. If it grows in wood record the type of wood and the vegetation nearby. Draw it, make a spore print. The type of cap, type of stem, color of flesh, color of gills, are useful too.

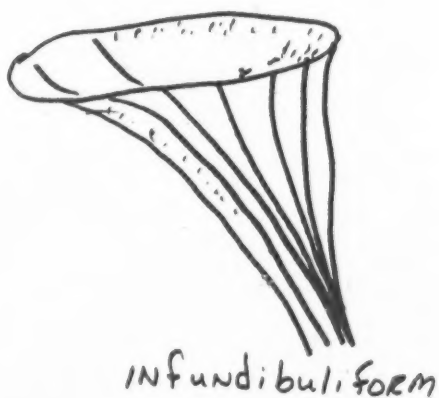
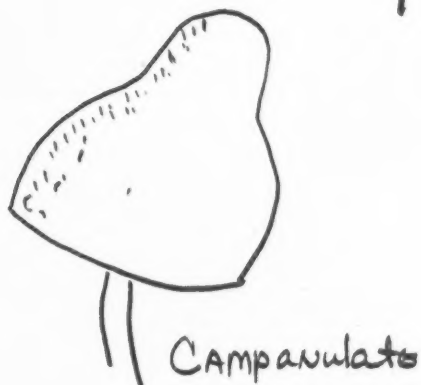
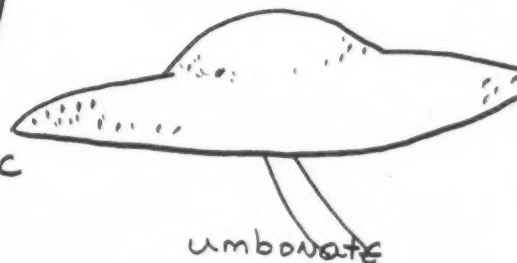
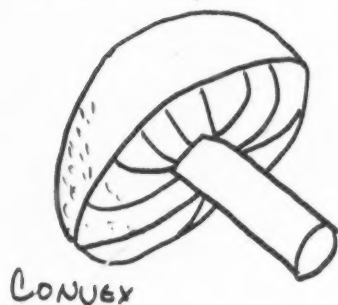
To go out in the field you will need a field book. Several are available at the Center. No mushrooms have been described because positive identification with a good manual is a must.



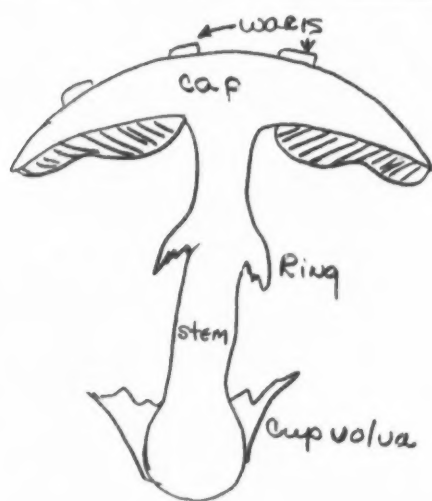
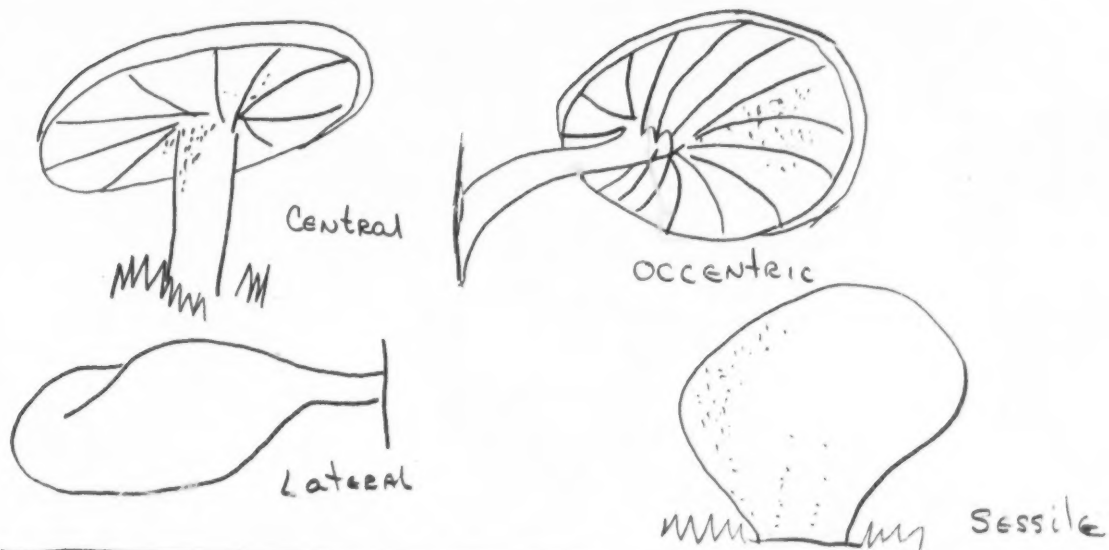
Gill Attachment



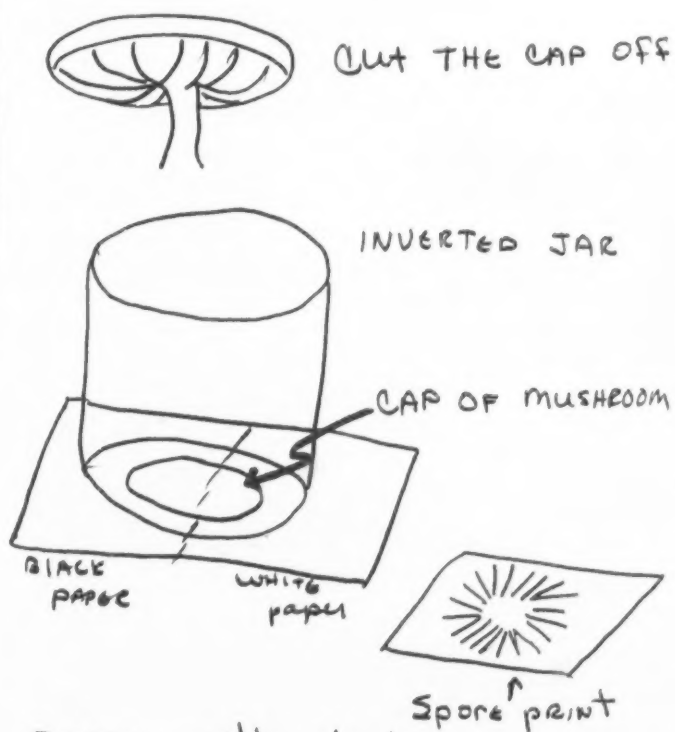
Cap Shape



Stem Attachment



MAKING A Spore Print



-141b-

Spray with plastic to make permanent

ACTIVITY 58, Grades 3-8, Area ADEGOH

*THE DISCIPLINE OF MATHEMATICS
AS IT RELATES TO OUTDOOR EDUCATION
BY C.W. PARKER*

Pure math alone might be difficult to teach on the Balarat site. Math teachers and others who teach outside the natural science field should have some knowledge of plant and animal life in the montane zone. Further, a little knowledge of geology, meteorology and astronomy should prove beneficial.

This paper will contain some ideas which relate to the math discipline as they might be used in an outdoor education laboratory. Some of the thinking is, I hope, original. Some comes from a paper done about a year ago and co-authored by Mrs. Lucy Beers and this writer. That paper was refined by Mrs. Beers for a project in an ecology course taken just this past summer.

My personal philosophy is that these thoughts should be individualized by other teachers who inject their own thinking and ingenuity. It is a beginning but must essentially be left open ended.

Anything dealing with how far, how tall, how deep, how many, how long, how dense, or any type census at least relates to the area of mathematics.

It would be advantageous for the teacher to scout the Balarat site so he will have definite projects in mind and can lay the ground work prior to the day of the excursion. I will admit there are some skills and fundamentals that can best be taught in the classroom or on the school grounds. Below is a partial listing of some things which might be done with a group of students. It probably will need to be adapted for your level.

1. Measurement without formal instruments and units. Let students first measure various parts or appendages of their own bodies such as the spread from finger tip to finger tip with arms outstretched, their normal pace (different uphill or down), their cubit (elbow to fingertip extended), Hand span, shoe length, foot, etc.
2. Make a rough sketch of an area so later a more detailed scale drawing could be made. A map of trails and prominent features would be very interesting. The teaching of proportions should precede work with scale drawings.
3. Determine that an acre is $1/640$ th. of a square mile. From this deduce that an acre is approximately 208' by 208'. Have students pace it off and stake it out. Show how to obtain a right angle by inscribing an angle in a semi-circle. I suggest the use of binder twine and a stick for marking on the ground.
4. More formal measurement. The 100' chain and chaining pins, The yard stick and meter stick would be of benefit. Boys, especially, will be interested in linear measurement of 100 yds. an $\frac{1}{4}$ mile (440 yds). The out of doors is a great place to compare the 100M. and 100Yd. dash

Continuation of Activity 58

- for length. Using a meter stick could lead to some study of the metric system of measurement. How deeply you delve into it should be determined by the students' interest. With some motivation provided this could be pursued back in the classroom at a later date. It might be fun on the trip to convert M P H. to Kilometers Per Hour.
5. Census and or counting of individual species of flora or fauna, density of plants in a particular plot, tree rings, tabulating, charting and graphing of a great variety of information obtained on the site.
 6. Measuring and computing the volume of a tree trunk. Explain that a board foot of lumber is equivalent to one foot in length, one foot in width and one INCH in thickness. Calculate the volume of a Ponderosa trunk (squared off) then convert into board feet. Example: If the trunk of the tree just below the limbs would yield a 12" by 12" timber 15 ft. long we would multiply the length in feet by the width in feet by the thickness in INCHES. $15' \times 1' \times 12" = 180 \text{ BD FT.}$ Be sure to tell them what it will build and how long it took the tree to attain its present size. Mrs. Beers in her paper suggested the use of a Doyle rule. Pace off 66 feet from the tree. Sight along the thin side of the rule (with 1,2,3,4) lining up the bottom of the rule in line with the base of the tree, extend your arm (elbow straight) and sight the tree top on the 1,2,3,4 line. Then on the "appropriate" side of the Doyle rule, trace your finger horizontally along the 1,2,3 or 4 you just measured till you meet the diameter in inches figure. At the point your two columns come together you can read the number of board feet.
 7. Determine the value of π . This is a perfect place for it. Establish the relationship between the diameter and the circumference of a tree. Using a piece of binder twine circle the trunk to obtain the circumference and divide that number of inches by π to determine the diameter. Students could even construct a pair of calipers with parallel jaws to be used to measure the diameter directly. A stump might do nicely to show a radius, a diameter, the circumference, an arc, a chord, a tangent, a secant and an arc of a circle. Tree rings can be used to show concentric circles.
 8. Practical problems. Determine the number of board feet of lumber in the two heads near the entrance to Balarat. Compute the cost of rough sawed lumber used based on current prices. Using figures supplied by the driver compute the cost of the bus for the trip. Distance $\div$ miles per gallon = the number of gallons used then multiply by the cost per gallon. Slope = rise/run. Use a simple carpenter's level. Fibanachi numbers (1,2,3,5,8,13,21 etc.) may be seen in leaf, petal, pine cone and sunflower seed arrangements. Look for symmetry in nature. (The left and right halves of a pine tree.) Look for prime numbers in nature. (2,3,5,7,11,13,17,19,23,29, etc.)

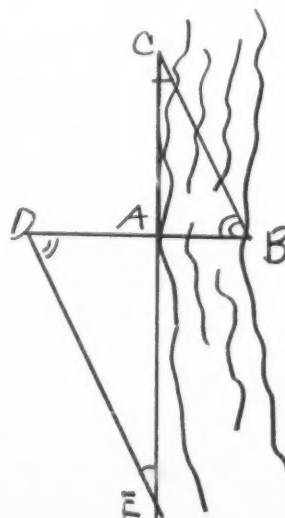
Continuation of Activity 58

9. Trigonometry as applied to simple survey and length or distance could certainly be done on the Balarat site. It is my understanding that a transit and other instruments may be borrowed from the University of Denver math lab (Dr. Ruth Hoffman).
10. Areas of ordinary geometric figures such as rectangles, squares, triangles of all kinds, parallelograms, trapezoids and circles could be found both outside and in and around the buildings. Some volumes might also be obtained.
11. I would like to see temperatures, barometric pressures, humidity, precipitation, wind velocity and direction recorded for purposes of comparison. Possibly something could be done toward weather prediction. A study of stars, planets and constellations seems desirable.
12. Consideration should be given to the development of a museum of some sort on the site. This could be started initially by collecting and identifying rocks. This collection wouldn't even need a roof.

PROBLEM: Find the distance from point A to point B without crossing the stream or getting wet.
 Sight a tree, rock, stump or some object at point B. Using stakes at A, C, D, & E construct two similar triangles. Similar triangles need not have the same size but must have the same shape. You must use the mathematical fact that corresponding sides of similar triangles are proportional. $\angle C = \angle E$ and $\angle D = \angle B$ by formal proof in geometry. The vertical angles at A are also equal. They need not be right angles. Pace off distances AB, AC, & AE and solve for AB using the principles of proportion. $\frac{AB}{AD} = \frac{AC}{AE}$ If AD = 30 yds, AC = 35 yds and AE = 70 yds.

our proportion becomes: $\frac{AB}{30} = \frac{35}{70}$ Cross multiply $70AB = 30 \times 35$

$$\frac{70 AB}{70} = \frac{1050}{70} \quad \text{and } AB = 15 \text{ yds}$$



Continuation of Activity 58.

PROBLEM: Find distance AB. Using the Pythagorean theorem

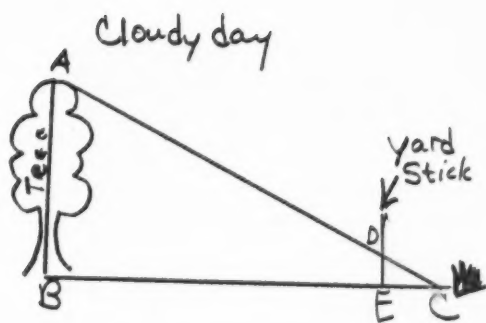
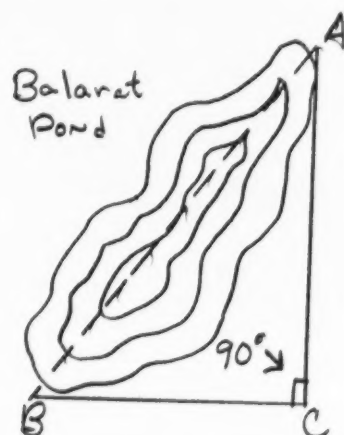
$AC^2 + BC^2 = AB^2$. Pace off AC & BC. Suppose they are 30 & 40 yds.

$AC^2 + BC^2 = AB^2$ becomes $30^2 + 40^2 = AB^2$
 $900 + 1600 = AB^2$

$$2500 = AB^2$$

$$\sqrt{2500} = \sqrt{AB^2}$$

$$50 \text{ yds.} = AB$$

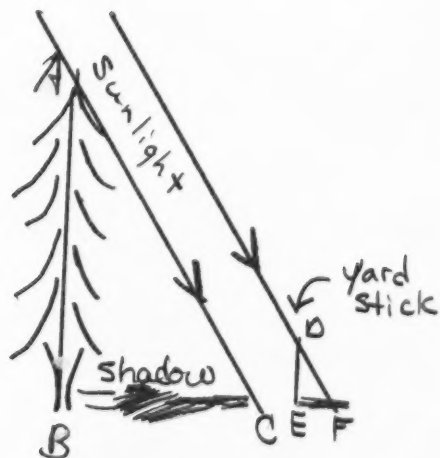


$$DE = 15'', EC = 18'' + BC = 50'$$

$$\frac{AB}{BC} = \frac{DE}{EC}, \quad \frac{AB}{50} = \frac{15}{18}$$

$$18 AB = 50 \times 15$$

$$\frac{18 AB}{18} = \frac{750}{18}, \quad AB = 41 \frac{2}{3}'$$



$$BC = 12', DE = 3', EF = 1 \frac{1}{2}'$$

$$\frac{AB}{BC} = \frac{DE}{EF}, \quad \frac{AB}{12} = \frac{3}{1 \frac{1}{2}}$$

$$1 \frac{1}{2} AB = 3 \times 12$$

$$\frac{1 \frac{1}{2} AB}{1 \frac{1}{2}} = \frac{36}{1 \frac{1}{2}}, \quad AB = 24 \text{ ft.}$$

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ACTIVITY 59; Elementary Level

ROCKS

By Alta Johnston
Susan Johnson

Objectives:

1. To use scientific methods on an elementary level.
2. To classify rocks which have been brought to school by members of the class or which have been gathered on a field trip.

Classification System-based on these tests and observations

- 1) Color--wash the rock
break the rock-to see past the weathered exterior
- 2) Texture--use words to describe the feel -bumpy-smooth-rough
- 3) Luster--use words to describe the look--such as shiny-dull-sparkly.
- 4) Composition--made of other rocks--all the same --shape... perhaps crystalline and symmetrical.
- 5)a. Hardness--try scratching the rock with various instruments try using the rock to scratch something--like glass or another rock
- 5)b. Breaking--tap with a hammer-pound rocks together--pull apart (discuss weathering of rocks and perhaps experiment with freezing water in a closed pop bottle or a plastic container to watch it explode or distort the container--keep it on your windowsill on a cold day.)
- 6) "Streak"--write with the rock as you would with a piece of brick--this is related to hardness. Use unglazed porcelain or try it on cement the color of the dust or writing powder may be a different color.
7. Test with a magnet--test by rubbing it to see if it will become a "magnet"--read the story of the discovery of the magnet-magnetite as a rock form.
8. Dissolving--Keep it in water--discuss salt etc.
9. Melting--heat it up--discuss metals that come from rocks that will melt (lead).
10. "Foaming"--test rock with hydrochloric acid or preferably vinegar it it works as I remember it should.
11. Make up tests based on what the class can imagine--try smelling or even tasting (a clean one) to see if there are notable differences--use magnifying glasses and as many types of equipment as are available.

Activity 59 cont.

Rock Testing Equipment

Crystals--salt in solution (water)

glass container

string-to catch salt crystals

pencil to hold string suspended into containers

Hardness--broken glass

penny

knife

file

Breaking rocks--rock hammer

"Streak"--unglazed porcelain (or cement)

Magnetic properties--a magnet

Dissolving--jar of water

Melting--hot plate

metal can

Foaming--vinegar -if it fails use hydrochloric acid.

ACTIVITY 60; Primary Level

SOIL

by Alta Johnston

Objective

To learn about the surrounding soil.

Materials needed:

Soil
Paper
magnifying glass
Cups
Seeds

Discussion:

1. Have you ever looked at a pile of dirt or soil?
2. What does it look like? What color is it? Light or Dark?
How does it feel?
3. How does it differ from place to place?
4. What shapes do you expect to see in the soil?
5. What samples of soil will grow plants effectively?

Procedure:

1. Each pupil bring a sample of soil from their yard.
2. Categorize by color-have each sample on a sheet of paper.
If possible record what areas from town they are from-
(ex. possibly the darker soil from the west end).
3. Observe the grains of soil by use of a magnifying glass
where by each child will use. Feel the texture.
4. Record the findings as to:
a--clay like soil
b--sandy like soil
c--humus soil-combination of decayed plants and
or plant parts.
d--shapes of the grains(sharp feeling;smooth feeling)
5. Each pupil involved-
a. put soil in cups
b. plant seeds-water-place in sunny area and warm.
6. Make a graph for each child to record daily as to the
growth by a method of measuring. (ex. names of soil, light
and dark.)
7. Observe and conclude which soils are giving the best results
as to productivity .

GLOSSARY

- BIOME:** Major ecological groupings of organisms. The major biomes of the world are listed as: tundra, taiga, deciduous forest, grassland (prairie, steppe, pampas, veldt), chaparral, tropical rain forest, tropical deciduous forest, tropical scrub forest, tropical savanna, desert, mountains, and permanent ice.
- BIOTA:** A general term for organisms of all three kingdoms--plant, animal, and protist.
- CHAPARRAL:** Small trees and large shrubs. Sometimes referred to as "scrub".
- CLIMAX:** The final stage of plant and forest succession as the product of the interaction of climate, interrelated biota, the underlying soil, and the topographic site over a period of time.
- COMMUNITIES:** A body or group of species growing in a specific area and in association with a complex of lesser plants and animals.
- CONIFERS:** Trees that bear their seeds in conspicuous cones.
- ECOSYSTEM:** The plants, animals, and the environment- including the air, the soil, and the water- which constitute a complex system in which each factor and individual is conditioned by, and in itself conditions, the other factors comprising the complex.
- ECOTONE:** The zone between two associations such as the transition zone between grassland and forest. This zone may vary widely in width and is usually a belt rather than a sharp line.
- EUTROPIC:** The natural succession of nature towards a different state. In terms of ponds--it is the filling in of a pond with organic materials until it becomes a bog.
- FORB:** Any non-grasslike herb.
- HORIZON:** The zones, or layers, describing a type of soil.
A-horizon: The surface layer.
B-horizon: Below A-horizon-the zone of accumulation.
C-horizon: The zone of clay deposition.
(The A,B,+C-Horizons are further broken down into subzones A₁, A₂, etc.)
- KRUMHOLTZ:** Lateral rather than vertical growth in trees.
- LICHENS:** Small plants found clinging tightly to rocks (sometimes to trees)..

Glossary Cont.

Lichens continued; Lichens have no roots, stems, or leaves. They are usually a dull gray-green; occasionally yellow or orange- never bright green.

MACRO: A word element meaning "large".

MICRO: A word element meaning "small".

MORAINE: Rocks and materials which are deposited on the sides (lateral moraine) and front (terminal moraine) of a glacier.

PAMPAS: Grasslands (mainly used to describe South American grassland).

PHOTOSYNTHESIS: The process by which plants convert light energy into food--substances that contain chemical energy.

PROTISTS: The kingdom organisms that possesses some of the characteristics of both animals and plants. The protists are mostly microscopic forms.

SAVANNA: Tall grassland biomes. (usually used to describe areas of South America and Africa)

STEPPE: Grasslands of eastern Europe and Asia.

TAIGA: Broad biome which extends across Eurasia and North America below the tundra biome.

TUNDRA: Polar biome in the Northern Hemisphere.

UNDERSTORY: The vegetation growing on the forest floor.

VELDT: Grasslands of Southern Africa.